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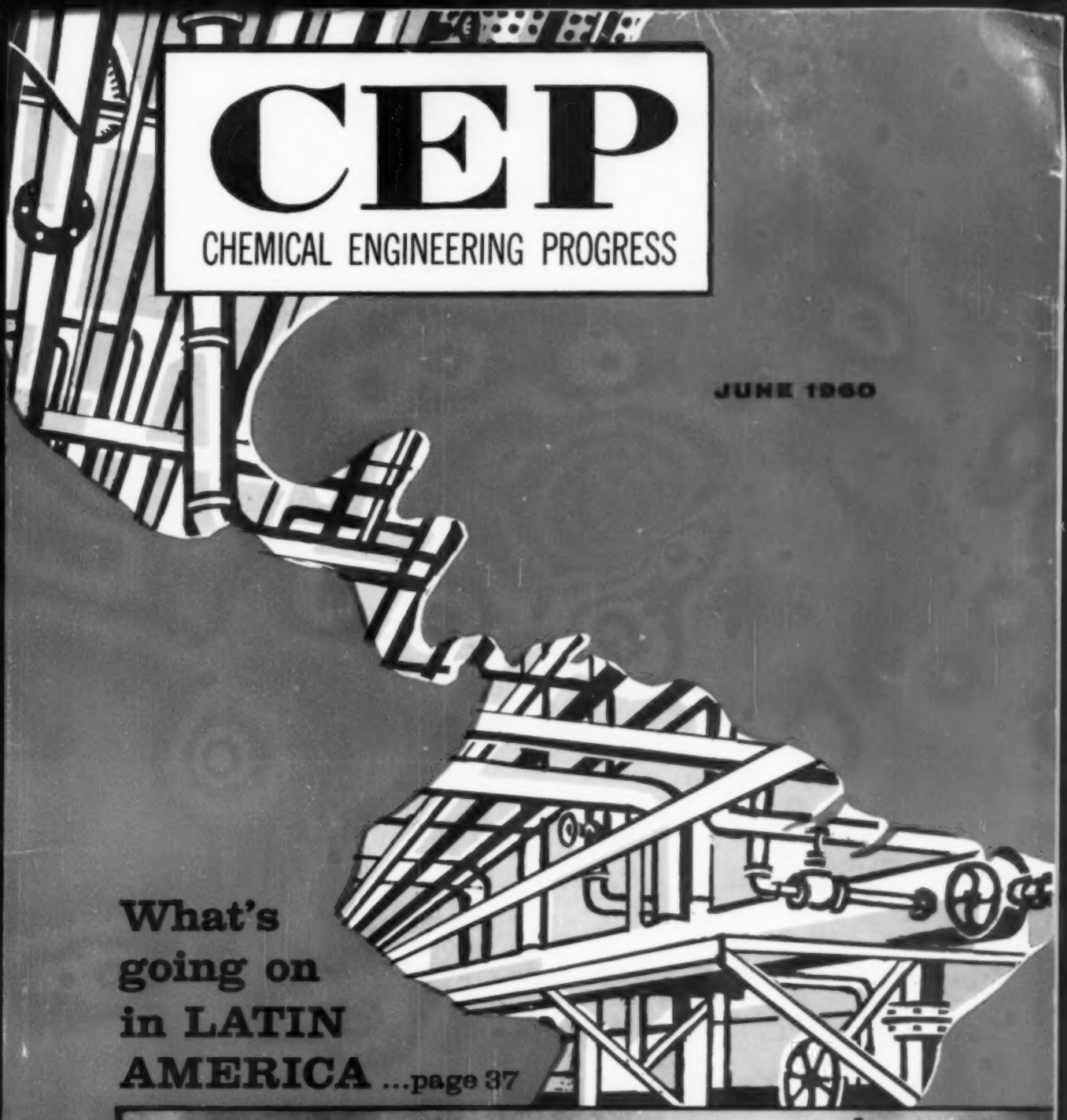
CHEMICAL ENGINEERING PROGRESS

JUNE 1960



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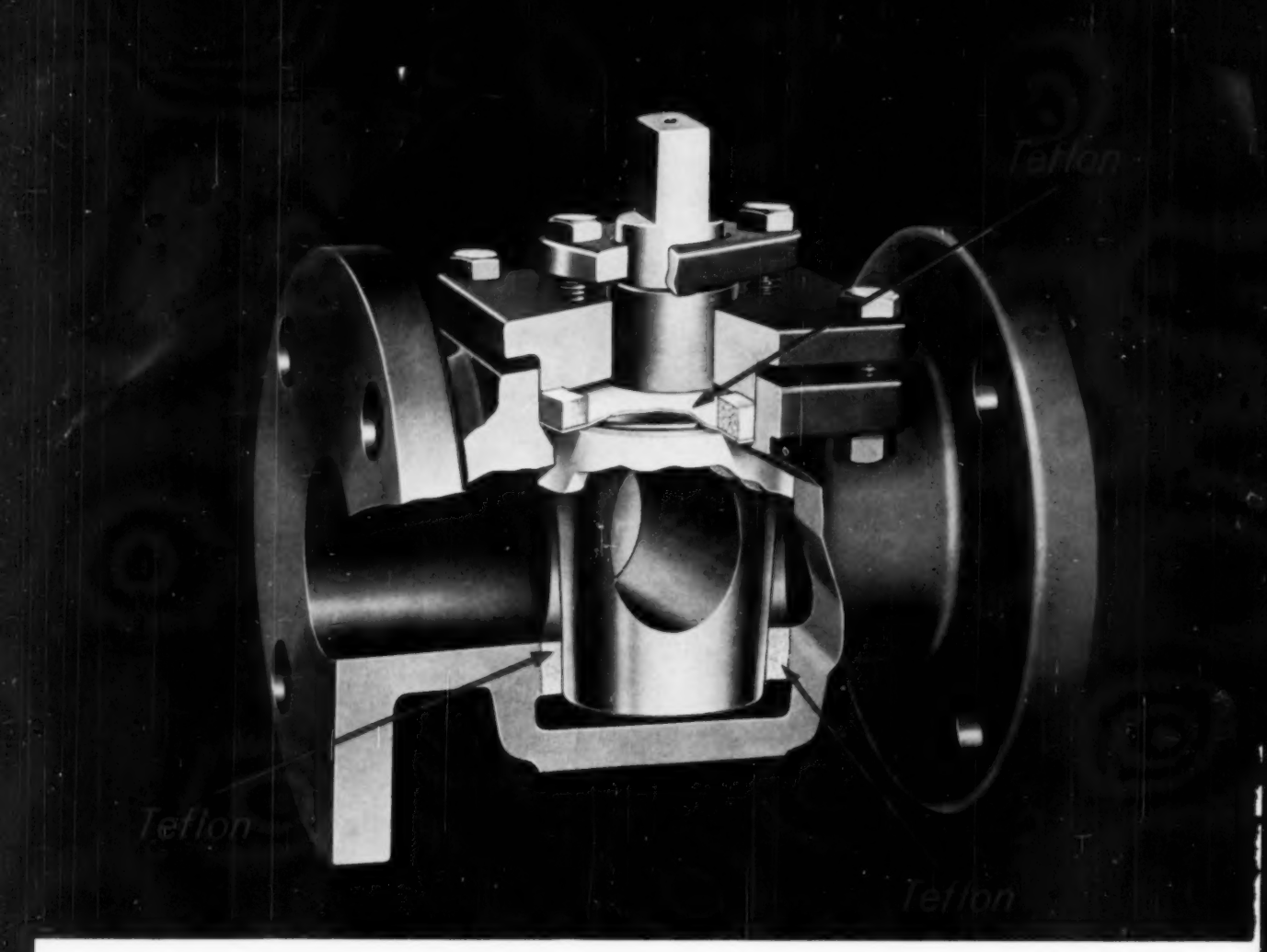

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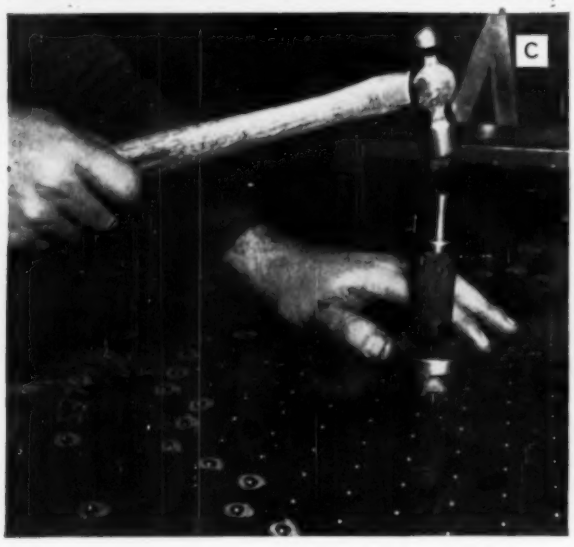

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LUMMUS

ENGINEERS AND CONSTRUCTORS FOR INDUSTRY

NEW SHELL PROCESS ETHYLENE-OXIDE PLANT TO GO ON STREAM FOR OLIN MATHIESON IN 1960

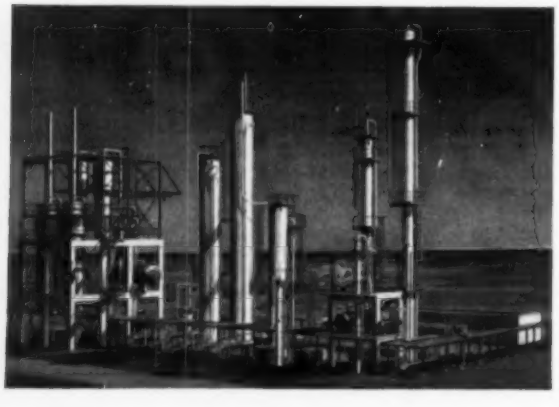
Olin Mathieson Chemical Corporation's new ethylene oxide plant at their Doe Run works, at Brandenburg, Kentucky is scheduled to go on stream late in 1960.

Engineered and constructed by The Lummus Company, the plant will employ the Shell Development Company's process for the direct oxidation of ethylene to ethylene oxide. The ethylene oxide product will be converted into derivatives for use in the manufacture of antifreeze, industrial coolants, hydraulic brake fluids, detergents and chemical intermediates.

Feed for the new plant will come from Olin Mathieson's ethylene plant, also located at Doe Run.

The new plant is part of a recently announced $30 million expansion program for Olin Mathieson's Chemicals Division. It is the fourth Shell process ethylene-oxide plant to be designed, engineered and constructed by Lummus in the last several years. The other three are operated by Calcasieu Chemical Corporation, at Lake Charles, La.; Wyandotte Chemical Corporation at Geismar, La.; and Petrochemicals, Ltd. at Partington, England.

For ethylene oxide and ethylene glycol, or for any type of chemical or petrochemical plant, Lummus' half century of world-wide experience on more than 850 plants for the process industries is at your disposal.



'SHELL' HDS UNIT FOR KOPPARTRANS OLJEAKTIEBOLAG

This Catalytic Desulfurisation Unit for treating 8000 BSD of Catformer feedstock is the latest addition by Lummus to the modern processing facilities at Koppartrans' Gothenburg Refinery. It utilizes the 'Shell' Vapor Phase Catalytic Process and provides the high quality low sulfur naphtha required for the ultimate production of high octane gasoline. Lummus has engineered and built a large number of similar hydrodesulfurisation plants all over the world. This is the latest in Europe. Lummus installed the successful prototype unit for Shell at their Stanlow Refinery in England.

B^2R^2

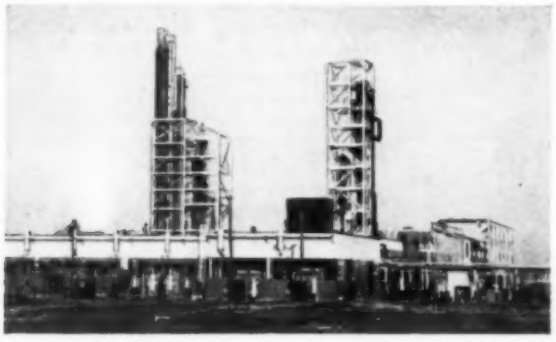
AEC Selects Lummus for Architect-Engineering and Construction Services on $10 Million High Flux Beam Research Reactor

The Atomic Energy Commission has selected The Lummus Company for architect-engineering and construction services on a proposed $10 million research reactor.

At the time of the selection, the A.E.C. said it had chosen the Lummus proposal as a basis for contract negotiations for a 20,000-thermal kilowatt, high-flux reactor. The installation will be built at the A.E.C.'s Brookhaven National Laboratory in Upton, N.Y. Curtiss-Wright Corporation will serve as the nuclear engineering subcontractor to The Lummus Company.

The reactor, authorized by Congress, will produce a high neutron flux – that is, a high intensity of neutrons. It will be used for such research projects as: studying the composition of solid materials, producing isotopes, and research on nuclear particles.

Ethylene Plant Expansion on Stream for Canadian Industries Limited



LUMMUS DESIGNS AND ENGINEERS 85% EXPANSION OF ETHYLENE PLANT AT EDMONTON, ALBERTA, CANADA

Expansion of C-I-L's ethylene facilities at Edmonton, Alberta, Canada, is completed and the plant now has a capacity of 46 million lbs. per year of high purity ethylene. The entire output of this unit is used by C-I-L to manufacture polyethylene.

Lummus designed and engineered the expansion of the existing cracking facilities, built in 1953, for the increased production of ethylene, and the ethane recovery unit for extracting ethane from natural gas.

As originally designed, the plant recovered ethylene from the cracking heater effluent and ethane from natural gas by oil absorption. In the expanded plant, additional capacity is obtained by withdrawing the natural gas portion and increasing the heater effluent.

The new low temperature ethane recovery plant has a demethanization unit which utilizes ethylene refrigeration to temperatures as low as –145°F. At C-I-L's request sufficient capacity has been designed into this unit to permit another expansion step in the future.

Up-to-date equipment was employed to ensure economical and efficient operation. Special efforts were made, wherever possible, to incorporate existing equipment into the expanded plant.

In addition to the C-I-L expansion project, Lummus has designed 13 complete ethylene plants, with a combined total capacity of over one billion pounds per year.

Over a half-century of Process-Industry experience

Here is just a partial list of chemicals for which Lummus has designed, engineered or constructed plants:

Acetone	Dichlorethane	Nitric acid
Acrolein	Dichlorobenzene	Phenol
Allethrin	Di-isobutyl alcohol	Phthalic anhydride
Ammonia	Ethylbenzene	Polyvinyl alcohol
Ammonium nitrate	Ethyl chloride	Polyvinyl pyrrolidone
Ammonium sulfate	Ethylene	Propargyl alcohol
Benzol	Ethylene glycol	Propylene
Beryllium metal	Ethylene oxide	Pyrrolidone
Bisphenol	Epon® resin	Styrene
Butadiene	Formaldehyde	Sulfuric acid
Butanediol	Heavy water	Surfactants
Butynediol	Hydrogen	Tetramer
Butyrolactone	Hydrogen sulfide	Trichlorethylene
Carbon black	Isopropyl alcohol	Trichlorobenzene
Caustic soda	Lamp black	Toluene
Chlorobenzene	Magnesium sulfate	Uranium oxide
Cumene	Mercuric nitrate	Vinyl acetate
Di-ammonium phosphate	Naphthalene	Vinyl pyrrolidone

Discuss your next chemical or petrochemical project with a Lummus representative.

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Lummus Appoints General Creasy To Head New York Division

DR. S. Z. AVEDIKIAN SUCCEEDS CREASY AS DIRECTOR OF ENGINEERING DEVELOPMENT CENTER

Major General William M. Creasy (U.S. Army retired) — who has been appointed to head Lummus New York Division.

William M. Creasy—Major General, U.S. Army retired – a Vice President of The Lummus Company, has been appointed to head the company's New York Division. At the same time, Dr. S. Z. Avedikian is joining The Lummus Company as Director of the Engineering Development Center in Newark, New Jersey. He succeeds General Creasy, who was formerly Director of the Engineering Development Center.

Previous to joining Lummus in 1958, General Creasy had served as Chief Chemical Officer of the Army since 1954. In this position, he was in charge of the Army Chemical Corps, whose activities include large-scale research and development, engineering, training and procurement in chemical, biological and radiological warfare. General Creasy received his B.S. degree from the United States Military Academy in 1926, and an M.S. degree in Chemical Engineering Practice from M.I.T. in 1936.

Dr. S. Z. Avedikian—Appointed Director of Lummus Engineering Development Center.

Before joining Lummus, Dr. Souren Z. Avedikian of Princeton, New Jersey, was co-founder of Avedikian and Company in 1932, Tidings Corporation of America in 1947, and S. Z. Avedikian & Associates in 1959. Holder of about 30 U.S. and foreign patents, Dr. Avedikian has been engaged in the research and development of processes and products for over 25 years, concentrating in heavy and fine chemicals, plastics, textiles, pharmaceuticals, paper, food processing, and amalgam cells.

For more information, turn to Data Service card, circle No. 63

book reviews

High temperature properties

PROPERTY MEASUREMENTS AT HIGH TEMPERATURES, W. D. Kingery, John Wiley and Sons, Inc., New York, N. Y. (1959), 416 p., $16.50.

Dr. Kingery's book will undoubtedly prove to be a useful guide to those scientists, materials engineers, and advanced college students whose task it is to conduct evaluation studies of materials for high-temperature service. His statements emphasizing the necessity for establishing the reliability of property data, which often are accepted without adequate knowledge of the pedigree of the materials described, are most welcome and timely.

If the "healthy skepticism" invoked by Dr. Kingery does indeed become a part of the thinking of a sufficient number of individuals active in the design of high-temperature systems, the author can consider his effort well rewarded.

This is a carefully planned and well conceived book, profusely illustrated with many excellent line drawings, indicating the construction of laboratory equipment and instruments. Each chapter contains an introductory section which sets the stage for the material to follow. A comprehensive outline of the theory then leads into discussions of the actual experimental equipment and techniques. The chapter closes with a section on applications, illustrating how the techniques are employed to develop useful information. Each chapter also contains a comprehensive list of references, subdivided under headings indicating the major areas of coverage.

The first three chapters are themselves introductory in nature and describe the methods used to measure temperature, the characteristics of laboratory refractories, and the construction of laboratory furnaces. The treatment of temperature measurement in Chapter 1 is well balanced between theory and practice. A few readers may wish for a more complete identification of the materials of construction used in the freezing-point furnace of Figure 1.12. Chapter 2 contains a concise discussion of the high temperature chemical stability of laboratory refractories, both singly and in combination. Qualitative charts (Figure 2.1, 2.2, and 2.3) illustrate the relative stabilities of oxides, nitrides, and carbides in a very graphic way. It is suggested that enlarged versions of these charts be made available for posting in laboratories where design work on high temperature systems is being carried out. Fabrication of special laboratory refractory shapes by slip casting, pressing, and extrusion is described. The types, characteristics, and general design features of many laboratory furnaces are well outlined in Chapter 3. This information should be helpful in many areas of high-temperature technology.

In the succeeding chapters, the real "meat" of the subject is presented, containing many useful semiquantitative appraisals of materials and methods, a wealth of experimental detail, all reflecting the author's own fine grasp of research techniques. Chapter 4 discusses heat conduction and radiation, with an excellent introductory coverage of the theory of heat flow. Measurement of density and thermal expansion is covered in Chapter 5. In Chapter 6, methods used to determine the strength, elasticity and deformation of solids under static and dynamic test conditions are described. Creep, creep-rupture, load-bearing capacity, impact, and hot hardness testing is comprehensively treated. All of Chapter 7 is devoted to that rather elusive property, thermal stress resistance. Viscosity measurements at high temperatures, about which relatively few summaries have appeared, are discussed in Chapter 8. Measurements of rate processes, Chapter 9, are treated next. These involve reaction or process kinetics of condensed phase materials which come to equilibrium slowly. Diffusion, weight-loss, decomposition rates, sintering, solid-solid, and liquid-solid reactions are considered in detail. Calorimetric measurements, involving direct determination of heat effects at elevated temperatures, are of major assistance in evaluating some of the thermodynamic properties of high-temperature materials. The author discusses these in Chapter 10, including coverage of drop methods, special calorimeters, and differential thermal analysis. Determination of phase equilibria

continued on page 10

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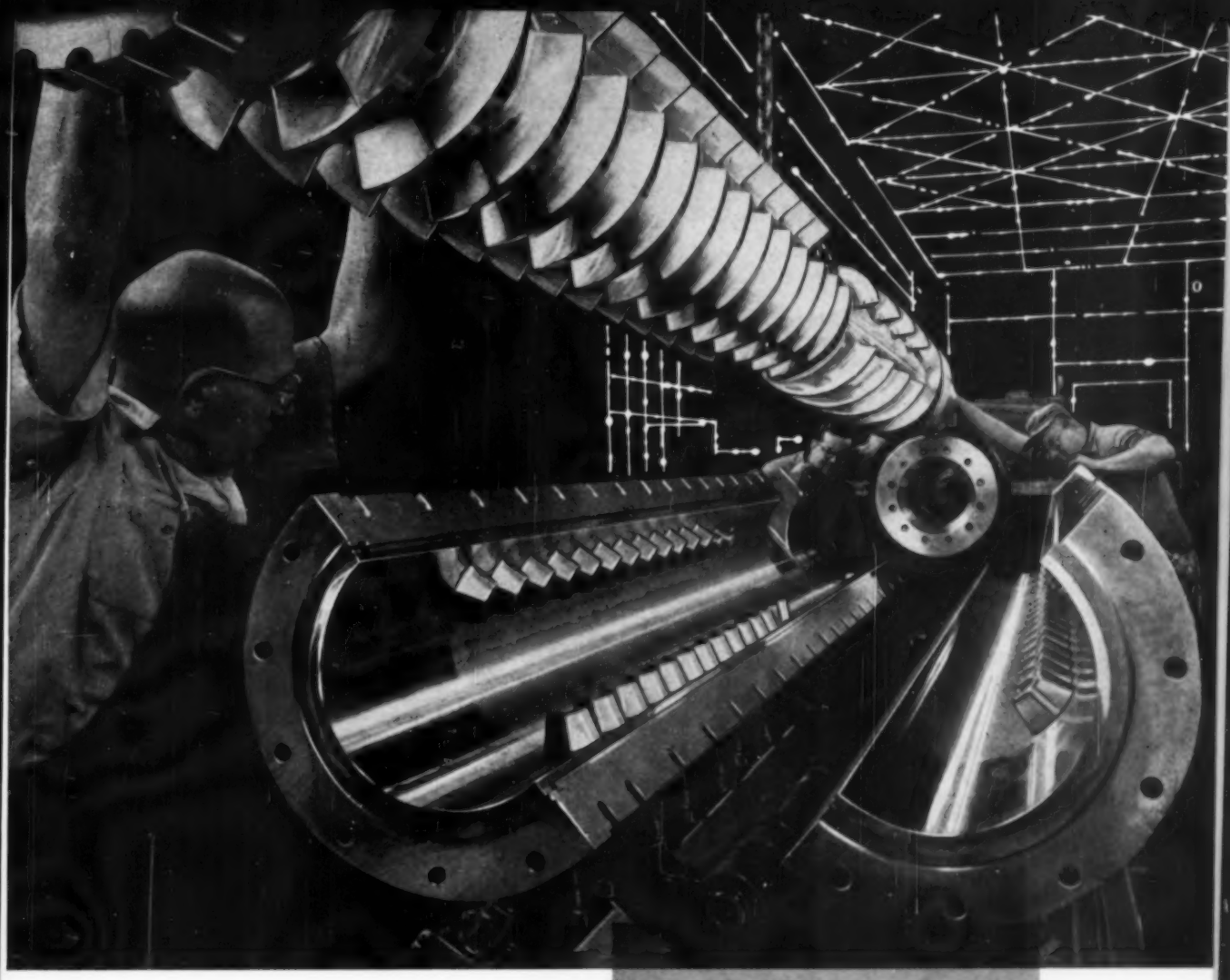

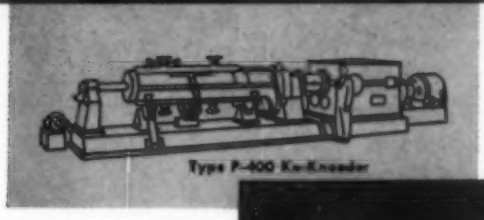

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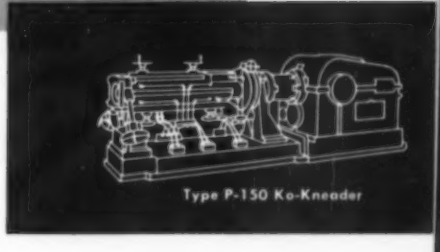

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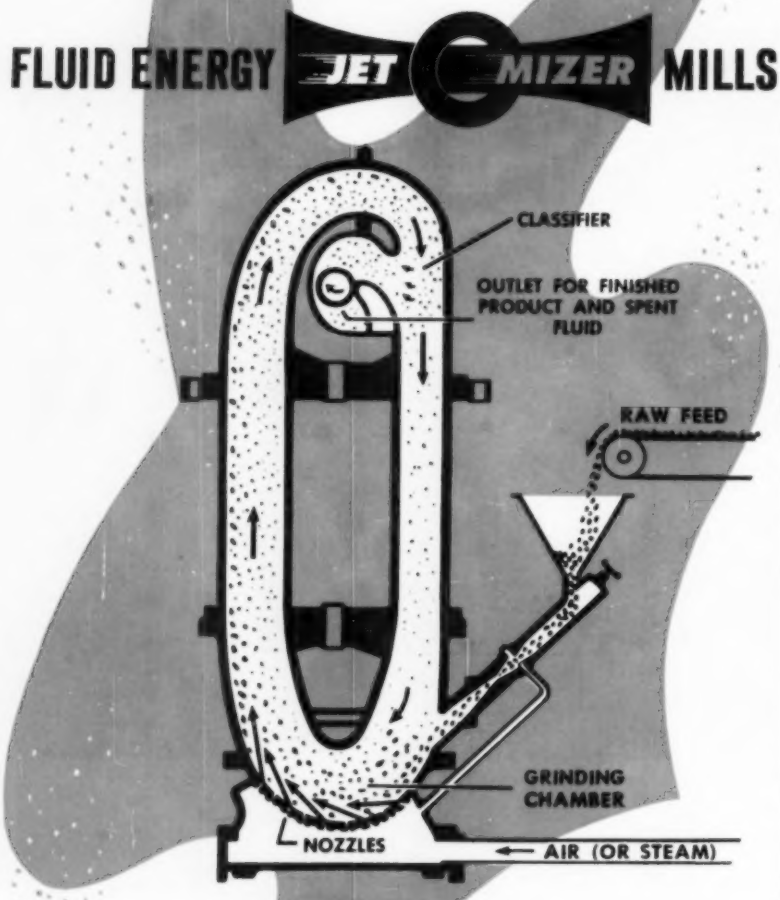

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Books

from page 8

and fusion characteristics of high temperature materials is outlined in Chapter 11, some of the important sections being thermal and differential thermal analysis, quenching methods, high temperature X-ray diffraction, high temperature microscopy, and fusion point observation. Chapter 12 contains a discussion of chemical thermodynamic measurements, including determination of equilibrium constants, activity coefficients, vapor pressure, gas-liquid and gas-solid chemical equilibria conditions, liquid-liquid and liquid-solid equilibria, and electrochemical values. High temperature electrical conductivity, dielectric, and magnetic property evaluation methods are useful for investigating the structure of solids and liquids. These methods are discussed in Chapter 13. Finally, general consideration is given, in Chapter 14, to the determination of surface energy characteristics of materials, as exemplified by measurements of the surface tension of liquids, surface energy of solids (fiber extension, thermal etching), contact angles, and interface energies. Several useful appendices are also presented.

The author's style is lucid and easy to follow. The design of the book is quite satisfactory. The many line drawings are clear and of sufficient size to permit identification of the components described in the text. Chapter and section headings, as well as page numbers, are set in boldface type, and the two-column page format makes reading easy. #

Reviewed by E. M. Sherwood, Consultant, Battelle Memorial Institute, Columbus, Ohio.

CHEMICAL ENGINEERING CALCULATIONS, Ernest J. Henley Herman Bieber, McGraw-Hill Book Co., New York, N. Y. (1959), 441 p., $9.00.

Chemical Engineering Calculations by Ernest J. Henley and Herman Bieber is an excellent first text for Chemical Engineering students.

Chapters 3, 4 and appendix A ("Problem Solutions Technique, Units of Measurement and Mathematical Techniques") are worthwhile and tie the particular presentation to fundamental techniques developed in other basic sciences. These chapters might be expanded in a future edition.

Chapters 5 and 6 "The Gaseous, Liquid and Solid States" and "Vapori-

zation" are presented in an excellent fashion with a good selection of problems, which include equilibrium distillation fundamentals.

Chapter 7 through 9 on "Material Balance" are a definite contribution. The majority of the Chemical Engineering operations are presented in a lucid fashion.

The first law presentation in chapter 10 makes the balance of the chapters through 15 extremely meaningful.

The problems have been well chosen and cover a useful variety of Chemical Engineering applications. #

FREE RADICALS, Collected papers of Francis Owen Rice, The Catholic University of America Press, Washington, D. C. (1958), 278 p., $5.00.

This volume represents a compendium of Professor Rice's investigations into free radical chemistry dating from 1931. The book has a great deal of interest for students of free radical chemistry, chiefly from a historical viewpoint. It traces some of the evolution of thinking concerning free radicals, their identities and characteristics, dating from essentially from the period when aliphatic free radicals were discovered by Paneth and Hofeditz in 1929. The articles are reprinted from a variety of sources, principally chemical and other scientific journals in the United States. The book represents a great convenience to the free radical chemist to have these articles brought together into one volume. The references associated with each article are of substantial value in delving further into this field. There is no explanatory or otherwise connecting editorial matter in the text other than the articles themselves. #

Reviewed by G. C. Szego, Space Technology Laboratories, Inc., Los Angeles, California.

FREE RADICALS: AN INTRODUCTION, A. F. Trotman-Dickenson, Methuen, London (1959), 142 p., $2.50.

This little volume represents firstly, a brief survey of this field of chemistry which has attracted a great deal of attention for various reasons in the last half-dozen years. By its own admission this book is intended to be an "introductory essay rather than a formal text". As such, it is an admirable volume. It serves as a very excellent introduction for an individual to

continued on page 12

FIRST . . . the valve itself —Lapp porcelain, chemically inert, to resist corrosion from any acid (except Hydrofluoric) in a process.

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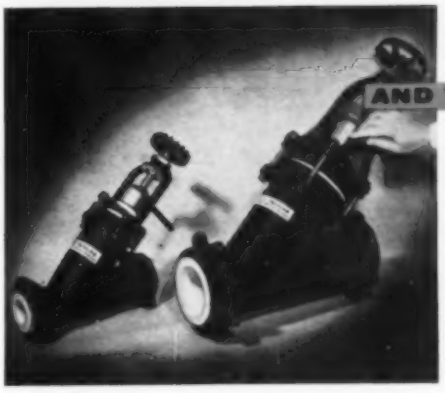

AND THEN, high-strength, chemical-resistant Epoxy resin, impregnating the Fiberglass, bonding it to the porcelain—adding the protection of armor to the corrosion resistance of Lapp chemical porcelain.

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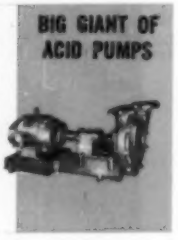

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For more information, turn to Data Service card, circle No. 35

Books

from page 11

whom this field is new. The book is one of a series of Methuen's monographs on chemical subjects. Even though self-characterized as an essay, this book should not be confused with a purely qualitative or historical review of the field of free radical chemistry. Professor Trotman-Dickenson is primarily a chemical kineticist and it is fundamentally from this point of view that the present volume has been written. It so happens that in the opinion of this reviewer, this is also the best an dmost basic approach to an understanding of the field of free radical chemistry. In addition to its brief discussion of the field, studied from both the inorganic and the organic free radical point of view, the last chapter suggests a very admirable list of references for those who wish to investigate various facets of free radical chemistry more thoroughly. Not only is there a good list of basic references, but these are broken down into specific categories, the better to help the reader. As an introduction to free radicals (exactly as described in the title), it is highly recommended. #

Reviewed by G. C. Szego, Space Technology Laboratories, Inc., Los Angeles, California.

CORPORATE DIAGRAMS AND ADMINISTRATIVE PERSONNEL OF THE CHEMICAL INDUSTRY, Edited by Kenneth R. Kern, Third Edition, Chemical Economic Services, Princeton, N.J. (1960), 82 p., $20.00 including supplement.

A comprehensive listing of organizational charts of prominent chemical companies is presented in this volume. It includes 43 line-diagrams and 33 management personnel listings.

REVISION SUPPLEMENT TO THE CHEMICAL ECONOMICS HANDBOOK, Chemical Information Services, Stanford Research Institute, Menlo Park, Calif., 270 p., $60.00 per year.

This supplement of Stanford Research Institute's continuing work on industry economics contains a wealth of data on production and consumption trends in the chemical industry. The present supplement contains over 850 monthly or quarterly data series of which 473 of the most significant are graphed for ready analysis. The Revision Supplement contains over 270 pages and is updated and reissued every two months.

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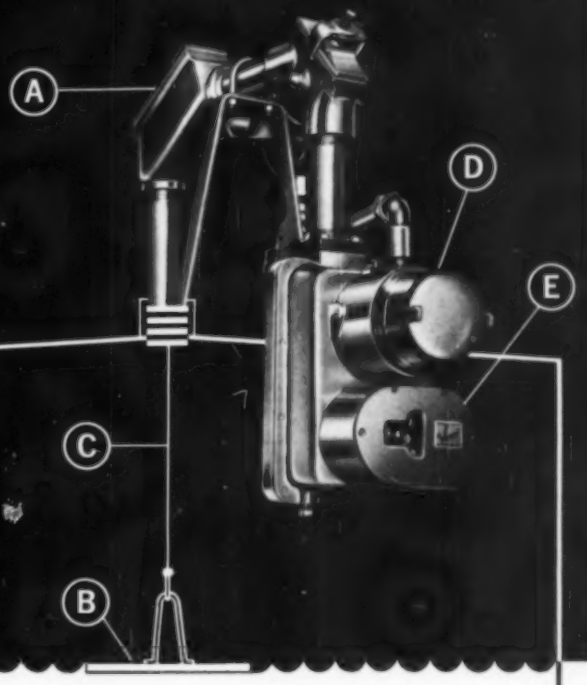

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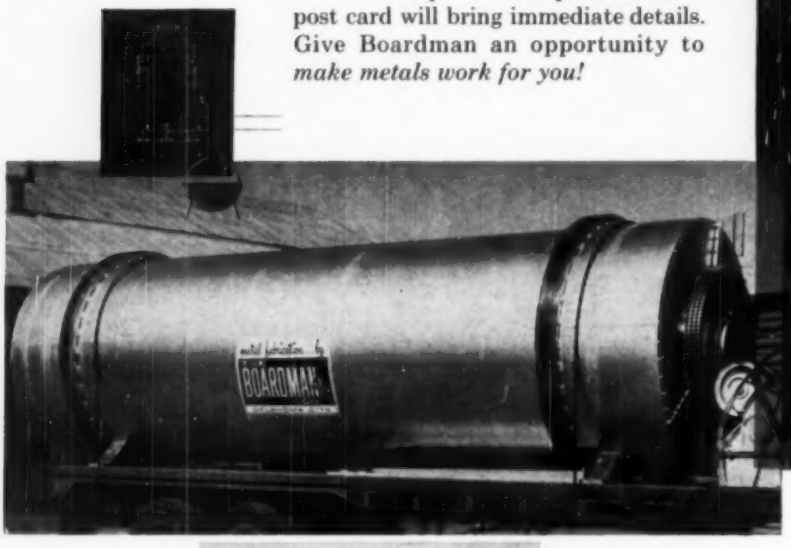

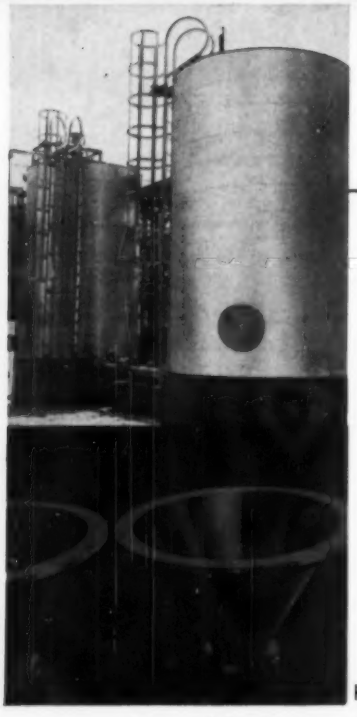

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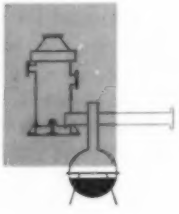

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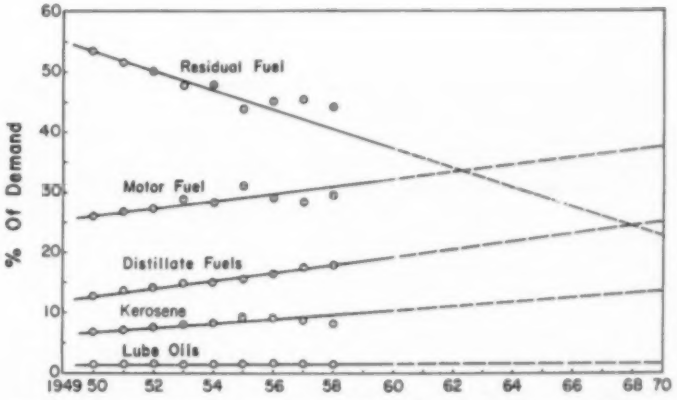
Upsurge in Latin American refining capacity

Sparked by expected three-fold increase in number of motor vehicles, explosive population rise, refining industry must expand 50% by 1969 to keep pace.

By 1969, REFINING CAPACITY in Latin America will have increased by more than 50% over 1959, say S. W. Curry and E. W. Schnabel of UOP in a paper prepared for the up-coming Mexico City meeting of A.I.Ch.E. and the Instituto Mexicano de Ingenieros Quimicos.

Daily average demand in 1970 will be approximately 4,300,000 barrels, it is predicted, compared to 1,411,600 barrels in 1959. Most pressing demand factors now, and in the foreseeable near future, are expected to be larger quantities of middle distillate fuels, and some increase in gasoline quantity, while demand for residual fuels drops gradually. Not only will gasoline volume be increasingly important, say the UOP analysts, but motor fuel octane requirements will rise throughout Latin America. (In several Latin American countries, only one grade of gasoline is presently marketed).

Average Latin American refinery today has an approximate crude capacity of 38,000 B/D, with a product distribution derived largely from heavy asphaltic crude stocks. If present trends continue, the number of operating refineries will increase from about 70 in 1959 to around 90 in 1970. In addition, while today about 20% of the crude is imported, by 1970, almost 100% of crude stock will be of Latin American origin.



Predicted petroleum product distribution in Latin American refineries to 1970

The population explosion

At the end of 1956 (latest recorded figures), the total population of Latin America was estimated at just under 190 million. By 1970, it is expected to reach 267 million, an increase of some 40%.

Motor vehicles in use in Latin America in 1956 were estimated at 3,400,000, including passenger cars and commercial vehicles. By 1970, there will probably be upwards of 9.5 million vehicles on the road. These two signs of expanding growth, say Curry and Schnabel, plus a continuing rise in the standard of living, will emphasize further the increasing demand of the Latin American area for petroleum products.

Octane ratings on way up

All Latin American refiners will be concerned in the future with the problem of increasing gasoline ratings, and will have to rely more and more on catalytic cracking or hydrocracking, plus catalytic reforming, alkylation, and polymerization. Present processing capacity of the average refinery includes about 10,000 B/D of thermal cracking, 4,900 B/D of catalytic cracking, 1,000 B/D of thermal and catalytic reforming, 1,300 B/D of hydrogen treating, 300 B/D of alkylation, and 240 B/D of polymerization, in addition to distillation equipment capable of charging 38,000 B/D of crude oil.

Getting the bugs out of jet fuel

Microorganisms and fungi apparently feed on fuel in storage tanks and form sludge and scum as a by-product, according to research reports from Southwest Research Institute. The bacteria seem to live in the water that accumulates in the bottom of the tanks. They migrate to the interface of the fuel-water zone and use the fuel for food. Waste produced by the bacteria then feeds the fungi which grow at the bottom of the water layer.

Pace-setting commercial chemicals for 1959

Year-end production figures for '59 . . . plus—up-to-date survey data on U.S. and Canadian synthetic ammonia production facilities.

YEAR-END PRODUCTION figures for 1959 just released by Stanford Research Institute show outstanding recoveries for many chemicals over 1958. In some cases, point out the Stanford researchers, these increases represent merely a recovery from an off-year in 1958; in other cases, they are all-time highs for these particular products. Some of the pack leaders were:

Chlorobenzene	up 43%
Vinyl & vinyl copolymers	up 40%
Sulfa drugs	up 40%
Phenol	up 37%
Liquid synthetic detergents (sales)	up 31%
Synthetic fibers (except rayon and acetate)	up 29%
Trichloroethylene	up 23%
Titanium dioxide	up 22%
Hydrofluoric acid	up 22%
Acetic acid	up 20%
Chlorine	up 19%
Urea	up 19%
Ammonia	up 16%

Ammonia survey

Also just released by Stanford Research (*Chemical Economics Handbook*) are up-to-the-minute data on synthetic ammonia production facilities in the U.S. and Canada. Response to the survey came from 47 of the 50 operating companies (44 in the U.S. and 6 in Canada). Figure 1 shows the 20 leading U.S. producers, ranked in order of producing capacity. It will be seen that, in spite of the large number of synthetic ammonia producers in the U.S., the first 5 account for more than 40% of total national capacity. Largest producer by far is Allied Chemical with slightly over 15% of U.S. capacity.

The Canadian ammonia picture is somewhat different. Consolidated Mining & Smelting is in a dominating position, followed at some distance by Cyanamid of Canada. The remaining four producers are of markedly less importance.

Figure 1. U.S. synthetic ammonia producers (January, 1960).

	Capacity		
	M tons per year	Percent of total	Cumulative percent
1. Allied Chemical	795	15.2	
2. Monsanto Chemical	408	7.8	
3. Phillips Chemical	383	7.3	
4. Du Pont	335	6.4	
5. Spencer Chemical	314	6.0	42.7
6. Shell Chemical	183	3.5	
7. Dow Chemical	151	2.9	
8. Commercial Solvents	140	2.7	
9. Olin-Mathieson Chemical	138	2.6	
10. Southern Nitrogen	127	2.4	56.8
11. California Chemical	116	2.2	
12. Mississippi Chemical	113	2.2	
13. Collier Carbon & Chemical	110	2.1	
14. Sun Oil	110	2.1	
15. Calumet Nitrogen Products	105	2.0	67.4
16. Solar Nitrogen Chemicals	105	2.0	
17. Petroleum Chemicals	100	1.9	
18. Hercules Powder	93	1.8	
19. Coop. Farm Chemicals Assoc.	92	1.8	
20. Tenn. Valley Authority	90	1.7	76.6
TOTAL	4,008	76.6	

Figure 2. Canadian synthetic ammonia producers (January, 1960).

	Capacity		
	M tons per year	Percent of total	Cumulative percent
1. Consol. Mining & Smelting	207	39.8	
2. Cyanamid of Canada	125	24.0	63.8
3. Canadian Industries	65	12.5	76.3
4. Sherritt Gordon Mines	56	10.8	87.1
5. Dow Chemical of Canada	36	6.9	94.0
6. Northwest Nitro-Chemicals	31	6.0	100.0
TOTAL	520	100.0	

Picture bright for overseas expansion

217 percent increase in assets, 155 percent in sales, in Monsanto overseas operation for six year period, says Board Chairman. Consumption abroad up in polystyrene, PVC resin, dodecyl benzene.

AN OPTIMISTIC PICTURE of the possibilities for overseas expansion of American chemical firms is painted by Charles Allen Thomas, chairman of the board of Monsanto Chemical. The gross overseas assets of Monsanto have increased 217 percent, from $72 million in 1953 to $228 million in 1959. This makes foreign assets about 17 percent of the company total, while sales amount to about 20 percent of the total. Despite increasing competition there are opportunities to be found overseas, Thomas told the National Federation of Financial Analysts Societies annual convention in New York City.

The attraction for American business to invest abroad is lower labor and research costs and the cutting into American exports of growing nationalism. But mainly, the rate of industrial expansion, faster at the moment than in this country, is responsible, according to Thomas. In eleven countries, Monsanto's overseas operations have successfully capitalized on the growing markets.

Consumption figures for the five year period 1954-58 show a considerable increase in:

- Polystyrene, 175 percent in France, 56 percent in Canada, 233 percent in Argentina.
- Polyvinyl chloride resin, 308 percent in Japan.
- Dodecyl benzene, 289 percent in Italy.

In all of these countries, Monsanto has an affiliate company.

United Kindom leads

Reviewing Monsanto's overseas operations, Thomas stated that chiefly responsible for the 217 percent increase in assets for the 1953-59 period were the United Kingdom area, 235 percent, and Asiatic-Pacific area, 230 percent. In the matter of sales for the same period, an increase of 155 percent is mostly accounted for by the Asiatic-Pacific area which outstripped the European and Western Hemisphere regions.

In listing various ways of setting up operations, he included providing know-how in exchange for equity; know-how plus dollars; partnerships or mergers, and raw materials in exchange for local currency to acquire equity. The Monsanto executive pointed out that while 100 percent ownership gives complete freedom of management, there often is local discrimination against the foreigner. Under the commercial codes of some nations, a minority holding 30 percent can vote equally with the majority shareholder on policy decisions.

Monsanto's prospectus for the future is bright. While shipments of bulk chemicals may increase, Thomas said, and export sales may shrink, their dollar volume may not necessarily decrease. But movement of the more sophisticated groups of specialty chemicals is increasing. These require greater technical sales and service effort, but command higher profit margins.

MIT chemical engineering curriculum under review

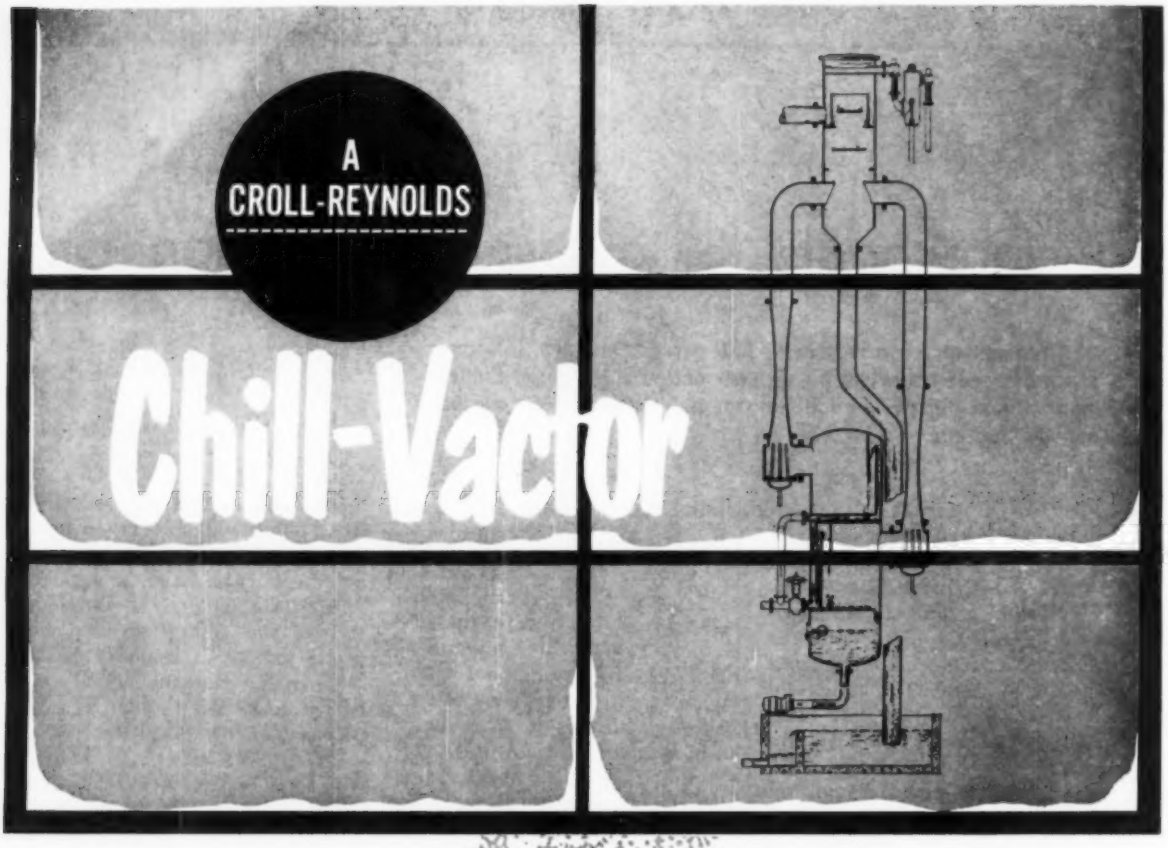
A three-man group of the MIT chemical engineering faculty has been relieved temporarily of teaching duties to carry out "a thorough review and possible revamping of the undergraduate program . . ." Detailed implementation of the desired changes is slated to begin with the Fall term, evolution of the whole program will probably take several years.

New entry in smog control race

A system which combines direct combustion with catalytic oxidation to burn from 80 to 90% of hydrocarbons and CO in auto exhausts is under development at Union Carbide. "Special new catalysts" are said to be the heart of the high-temperature device which is claimed to pass the requirements recently set up by the California Department of Public Health.

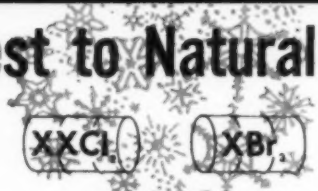
Chemical uses for depleted uranium stockpile

A recent AEC report on Potential Nonnuclear Uses for Depleted Uranium suggests that catalysts may prove to be a major use for stockpiled uranium from which the fissionable isotope has been extracted, particularly if specific catalysts can be developed for large-scale application in the refining and petrochemical areas.



Comes Nearest to Natural Refrigeration

Nature produces refrigeration (snow, sleet, and hail) indirectly by change of atmospheric pressure to bring warm water vapor in contact with cold air.



NO CHEMICAL REFRIGERANT OR ABSORBENT TO LEAK, CORRODE OR CRYSTALLIZE

In each case, water is its own refrigerant or cold air serves the purpose. Jet vacuum refrigeration comes nearest to this natural refrigeration.

As a method of industrial refrigeration, jet vacuum refrigeration is thoroughly established and is successful in many hundreds of industrial plants in capacities varying from a few tons to 4500 tons.

The unit sketched can be placed outdoors and operated continuously or intermittently in any climate. The equipment adapts itself readily to automatic control or is very easy to control manually. The unit is self-supporting. There are no moving parts, no noise, no vibration. The maintenance and supervision required are negligible.

While most vacuum installations are used to cool water, vacuum cooling is particularly efficient for cooling chemical solutions. Instead of the usual expensive heat transfer surface, only simple corrosion-resistant vessels are needed. Some process plants have dozens of separate units totaling thousands of tons of refrigeration just for the purpose of cooling chemical solutions. Their record of savings is remarkable.

There are many other applications, too. Fresh vegetables and other moist solids are readily cooled by jet vacuum refrigeration. By adding a heat exchanger bundle inside the vacuum chamber, gases can be cooled without circulating any liquid. In some cases, the automatic de-aerating effect of vacuum cooling is important.

Many installations of old style mechanical refrigeration could be replaced profitably with vacuum refrigeration, which costs much less to buy and somewhat less to operate.

All inquiries will be given careful engineering study without obligation.

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U.S.I. CHEMICAL NEWS

June ★ A Series for Chemists and Executives of the Solvents and Chemical Consuming Industries ★ 1960

Sodium Dispersions Now Sold by Several Companies

Many types of sodium dispersions are now being sold commercially by several companies. These firms already prepare sodium dispersions for their own chemical manufacturing operations, and so are familiar with the techniques involved.

Sodium dispersions, of course, have been recommended for many years for their high surface area and, consequently, high activity in reactions such as Claisen condensations, Wurtz type reactions, sodium alcoholate preparations, metalations, preparations of sodium alkyls and aryls, polymerizations and many others. Until dispersions were offered for sale commercially, however, they had to be made by the user in situ as required. Some special equipment and operator training are needed for dispersion preparation, and it is believed that these needs may have discouraged use of dispersions on a broader scale in the past, especially where small quantities were involved. The availability of commercial dispersions now is expected to increase their use in chemical reactions.

One supplier offers two standard types of sodium dispersions. The first is a solid composed of 50% sodium and 50% paraf-

MORE

Chemistry Booklet for The Elementary School Teacher Supplied by MCA

"Matter, Energy and Change", a booklet containing a course of study in chemistry for elementary school children, is being offered to school supervisors and teachers at below-cost prices, as an educational service of the Manufacturing Chemists' Association.

The 50-page booklet attempts to supply up-to-date knowledge to the science educator in the rapidly growing and changing field of chemistry. It presents this knowledge by outlining a series of explorations for the children. For youngsters through third grade, there are explorations into materials, changes, water, air and plants. For older children through sixth grade, there are explorations into the nature of matter, chemical reactions, electricity and matter, chemical tests, crystals and photography.

This booklet represents a part of MCA's extensive aid-to-education activities, designed to stimulate the understanding of chemistry at many levels.

Up-To-Date Catalog On Ethyl Alcohol Now Available from U.S.I.

132-Page Book Contains Complete Information on Pure Ethyl Alcohol and Denatured Alcohol Formulations

U.S.I.'s new Ethyl Alcohol catalog has just been published. Type style and format of the up-to-date edition have been carefully selected for easy reading. Comprehensive and thoroughly documented, this illustrated catalog covers:

(1) Pure ethyl alcohol—properties, specifications, shipping data.

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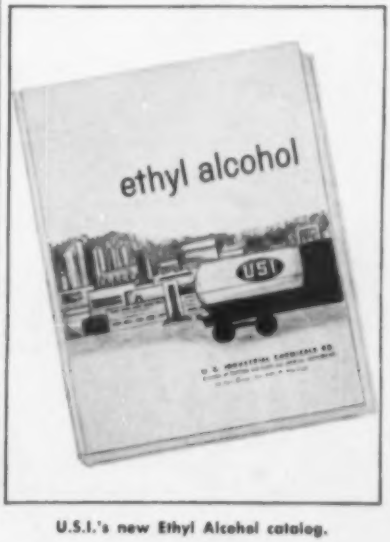
(3) Completely denatured alcohol formulas—authorized compositions, specifications, properties, shipping data.

(4) Proprietary solvents: SOLOX®, FILMEX® and ANSOLS®—authorized compositions, uses, specifications, properties, shipping data.

In addition, there is a section on the general properties of ethyl alcohol, including graphs, tables and bibliography, and a section on methods of testing. Appendices include standards, tests and assays of the ACS, NF and USP; container descriptions; gauging techniques for drums, tanktrucks and tankcars; and methods of handling. A glossary of terms completes the volume. Sections are tabbed for quick

MORE



U.S.I.'s new Ethyl Alcohol catalog.

Complete Property Data On Pure Nitric Acid Published Recently

The most current and accurate information available on the physicochemical properties of pure nitric acid has been collected, evaluated and presented in a 23-page report in the April issue of *Chemical Reviews*, a bimonthly publication of the American Chemical Society. The report includes discussions and data on: various methods of preparing nitric acid; all physical properties; self-ionization; thermodynamic properties; stability. It concludes with a list of the 216 references the authors used in compiling their data.

This collected information should be of particular value to laboratory, design and theoretical workers. It should also be useful to those engaged in the production, handling and storage of highly concentrated solutions of nitric acid for rocket fuel applications, as well as industrial producers and users of the material in any concentration.

Polyethylene Pipe and Fittings Joined by Fast Heat Sealing Technique

A patented process has been reported for joining polyethlene pipe and fittings, using nothing but heat and a special tool of simple design. In the process, called "Polyfusion", the outside of the pipe and inside of the fitting are heated on the Polyfusion tool and joined together to form one homogeneous piece. Any conventional heat source—flame or electric—can be used. No glue, cement, solvent or other material is needed. It is reported that only 10 to 20 seconds are required to fuse a joint.

CONTINUED

Alcohol Catalog

reference and each section has a table of contents.

A 20-page Government Regulations supplement is contained in a pocket inside the back cover, so that it can be easily replaced when changes are made in federal regulations. You can obtain a copy by making a request on your company's letterhead.

CONTINUED

Sodium Dispersions

fin or naphthalene binder, shaped into one-pound bricks. The other is a liquid made up of 50% sodium and 50% mineral oil. The company also offers other liquid dispersions as required.

A second company is marketing a crushed solids dispersion containing 50% sodium and 50% napthalene, as well as a dispersion gel consisting of 50% sodium and 2% aluminum stearate in mineral oil.

Still another company supplies four standard types of dispersions: 30% sodium and 50% sodium in xylene, and 30% sodium and 50% sodium in special naphtha cuts. They will also supply mineral oil dispersions on request.

New Microporous Films of Polyethylene Repel Water But Transmit Vapors

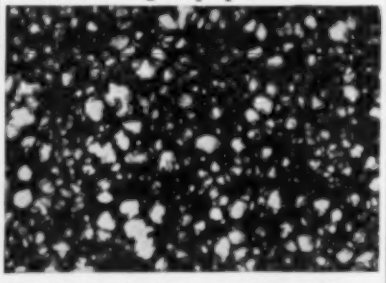
It is reported that a technique has been developed for producing extremely fine, uniform, interconnecting pores in polyethylene films. This makes the plastic vapor-transmitting and water-repellent at the same time. Films so prepared are being investigated for use in clothing, filters, medical equipment, solar water purification apparatus, electrodialysis equipment and other specialty applications.

As normally produced, these polyethylene films are said to have a porosity of about 80%, with all pores in the 8-12 micron range. Because of this extremely high void volume and the interconnecting structure, gases and vapors can diffuse through the films with very little interference. But because the polyethylene itself is hydrophobic, surface tension prevents water or aqueous liquids from penetrating the extremely fine pores. In this way, the material transmits water vapor but is completely water-repellent.

The pore structure is reportedly achieved through the use of starch as a leachable material. Polyethylene resin and starch are mixed, and the mixture is converted to sheet by any of the conventional methods such as calendering or extrusion. At this stage the starch in the sheet is encapsulated in very thin walls of polyethylene.

Next the sheet is immersed in boiling water to wet and expand the starch. Cornstarch, for example, will swell to well over twice its original volume. The expansion ruptures the plastic walls encapsulating the starch and results in the interconnecting pore structure. Starch is then removed by sulfuric acid hydrolysis and leaching.

It is claimed that by selecting starches of different particle sizes, altering the basic process, and varying the plastic formulation, a great variety of microporous plastic materials can be made having a tremendous range of properties.



Photomicrograph (200 magnification) shows typical pore structure of microporous polyethylene film. (Courtesy ESB—Reeves Corp.)

TECHNICAL DEVELOPMENTS

Information about manufacturers of these items may be obtained by writing U.S.I.

Polyethylene in powder form, a new development for coating metals, textiles, paper, glass, etc., for molding and other purposes, is described in technical data bulletin now available. Said to open new uses for polyethylene. **No. 1600**

Etching solution now on market makes fluorocarbon polymers bondable to other materials. Material is activated form of sodium in solvent. Extracts fluorine from surface, leaves carbonaceous film compatible with adhesives. **No. 1601**

Health factors in safe handling of chemicals is subject of first in series of pamphlets on safety, to be sold at nominal cost by MCA. Pamphlet is designed to acquaint non-chemists in chemical plants with toxicological terms, toxicity mechanisms, first aid principles. **No. 1602**

New portable conductivity and temperature measuring Solu Bridge for measuring tidal movements, salinity, industrial pollution, etc. is now on market. Covers, in 3 ranges, 40-400,000 micromhos/CM specific conductance. **No. 1603**

Portable water softener recently developed works by electric membrane process, is claimed 500 times more efficient than comparable electrical devices. Said to soften 2 gallons of hard water per hour on 10 watts of electricity. **No. 1604**

Coagulant aids, described in new bulletin, are used in municipal and industrial water systems, waste waters, cold and hot process softening, oil field waterflooding, brine clarification, color removal, high solids-liquid separation. **No. 1605**

New miniature infrared photoelectric scanner (proximity sensor) contains both light source and pick-up head in one small housing. Simplifies installation and operation in many counting and control applications. **No. 1606**

New dispersants and inhibitors have been developed to prevent formation of sludge in fuel oils. Dispersants are dialkyl dimethyl ammonium chlorides. Series of 14 fatty amine derivatives comprise the group of inhibitors. **No. 1607**

Chemical fume scrubbers of fiberglass-reinforced polyester resin now being designed. Units up to 47 feet high by 10 feet in diameter have been made. Plastic chosen for strength, lightness, chemical and flame resistance. **No. 1608**

Story of chemistry is subject of new book now being sold. Part I includes Egyptian, Greek, Arabic chemical knowledge and Western work to discovery of oxygen. Part II carries through latest discoveries in nuclear chemistry. **No. 1609**

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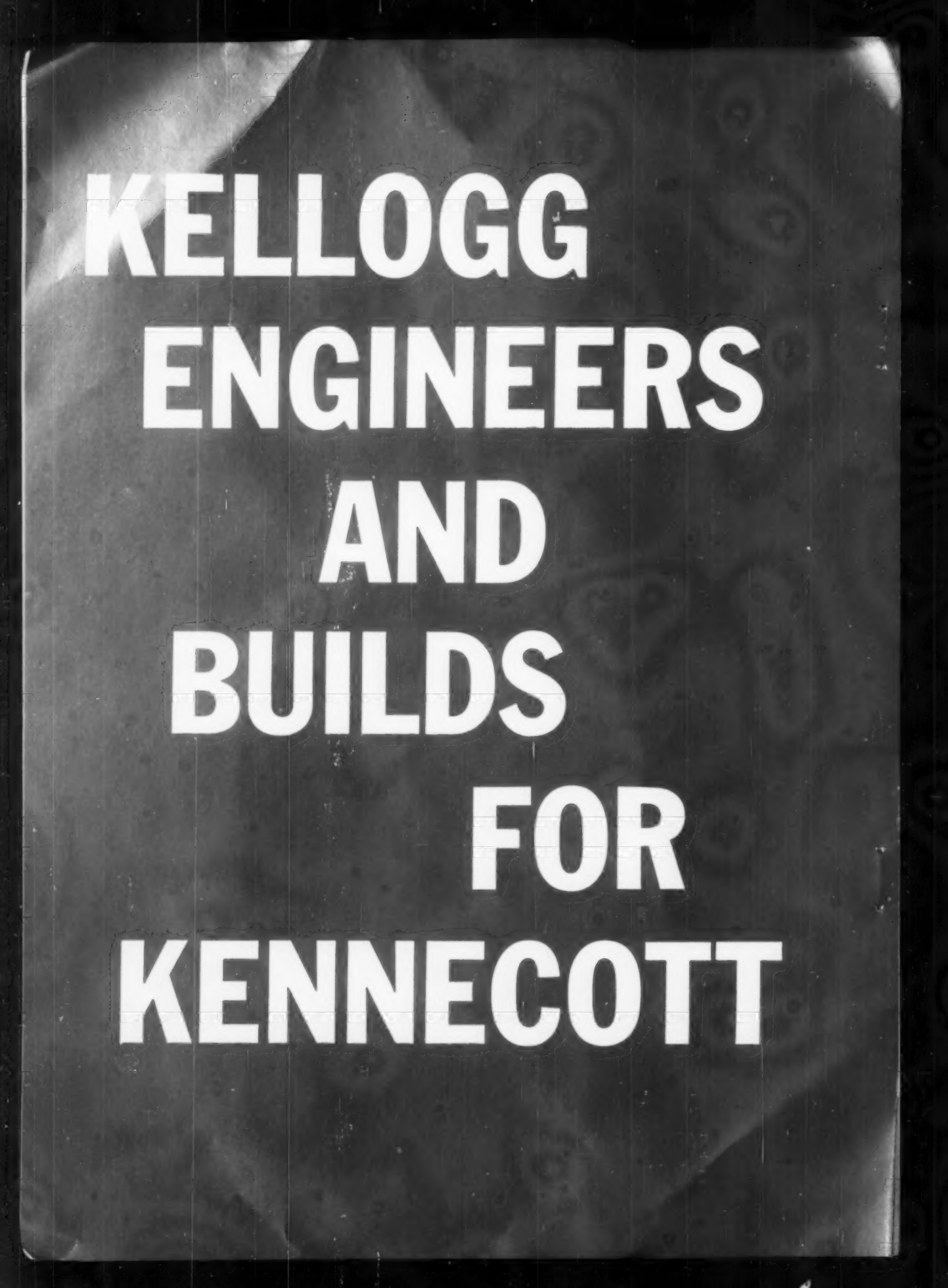
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KENNECOTT'S NEW $30-MILLION COPPER REFINERY DEMONSTRATES KELLOGG'S ECONOMIC APPROACH TO PLANT ENGINEERING, PROCUREMENT, CONSTRUCTION

Kennecott's new plant in Anne Arundel County, Maryland, is the newest and most modern electrolytic copper refinery in the United States. A model of efficient and economical execution, it is the result of close teamwork between Kennecott Refining Corporation and The M. W. Kellogg Company—to whom Kennecott assigned over-all responsibility for engineering, procurement, and construction.

This $30-million project demonstrates how large and complex plants can be designed and built for the optimum *predetermined* investment when all phases of the job are integrated into one unified operation by a single contractor. The method and the results are typical of the way Kellogg has worked with leading oil refiners, chemical companies and ore beneficiating firms.

Many design and engineering innovations resulted from this relationship. Among them were various ways to facilitate materials handling and expedite product flow. These included: a specially designed automatic anode take-off machine; straddle trucks for moving cathodes; and semi-automatic bundling for copper billets. Plant construction also was speeded by Kellogg, and erection costs cut, by production-line pouring—right in the plant—of 1,000 huge concrete cells, and by training workers on the spot to fabricate over 95,000 feet of plastic pipe at the plant site.

The complete story of Kellogg's engineering-procurement-construction assignment for Kennecott is available to you in a 12-page folder. You are also invited to send for Kellogg's brochure—"Planning the New Plant for Profits".

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Below is the new electrolytic copper refinery of Kennecott Refining Corporation (a subsidiary of Kennecott Copper Corporation) in Anne Arundel County, Maryland. Engineered and built by The M. W. Kellogg Company, this plant is expected to have a monthly capacity of 16,500 tons of 99.95% purity copper by mid-July.

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Business brisk at OSW

ONE OF THE GREATEST GROWING NEEDS of the U.S.A. is fresh water. The largest potential sources of fresh water is the sea water that is available in endless quantities along our 4,840 miles of coastline. During the seven years of its existence, the Office of Saline Water, a very small unit of Secretary Fred Eaton's far-flung Department of Interior, has examined and analyzed hundreds of saline water conversion processes. During that time, all of this technological and economic research has probably cost the American taxpayer less than it has cost to maintain the animals in the Washington Zoo. The budget has been out of all proportion to the work performed or to the magnitude of the need.

This fiscal year business has been especially brisk at the Office of Saline Water. The cause of this bustling activity has been the passage of Public Law 85-883 which authorizes the expenditure of $10,000,000 for the erection of five saline water conversion plants. What has really decided the office to get into high gear is the requirement of the law making it mandatory for the selection of processes for the demonstration plants to be chosen by certain fixed dates, the last of which was March 2, 1960. A few days earlier, on February 26, 1960, the Department of Interior announced that the process on which the fifth demonstration plant design would be based, is the freezing process.

Prior to that, the selection of processes and sites had all been made well within the time limit and other requirements set by the law. One plant had to be located in the arid southwest. Another was required to be located in the northern great plains area. And three had to be located on the coast—one on the Pacific, one on the Gulf, and one on the Atlantic.

With such a program to administer, comprising the choice of sites and processes and the actual construction and ultimate operation of five new plants, it is easy to understand that the 7 engineers, 2 chemists and 16 nontechnical people comprising the staff under its Director, Dr. Arthur L. Miller, is one of the busiest groups in the United States government. The high interest shown by this organization seems to have infected the entire segment of American industry concerned with the design, fabrication and construction of chemical engineering equipment. At this writing, 275 sets of bid plans have been bought—plans covering the distillation falling-film long-tube vertical evaporator process plant to be located at Freeport, Texas. Bids will be opened on May 24, 1960 at Washington, D.C.

Bid dates are yet to be announced for the four remaining processes. At this writing, the site has yet to be chosen for the fifth, the freezing process plant. As a matter of fact, the specific freezing process to be used, must still be selected. The Office of Saline Water in its effort to be sure that no good bets will be overlooked, has always presented the Process Selection Board with a volume of data on every conversion process that showed a reasonable chance of economically producing desalted water. (The board members, who represent science, industry, and government, are: Dr. Ralph A. Morgen, President of Rose Polytechnic Institute, Chairman; Mr. Dudley F. Phelps, President of The J. G. White Engineering Corporation, New York; Captain Ivan Monk, Bureau of Ships, United States Navy). The fifth process, the freezing process, has been no exception.

There have been three freezing processes considered that have stimulated the hopes of the OSW: the Carrier Process, the Cornell Process, and the recently announced Struthers Wells-Scientific Design Process. Much has been published about the Carrier Process, the pilot plant of which was

Selection of sites and processes to date:

No.	Location	Process	Engineer
1.	Freeport, Tex.	Distillation falling-film long-tube vertical evaporator	W. L. Badger Associates, Ann Arbor, Mich.
2.	San Diego, Calif.	Multi-stage flash distillation	Fluor Corp., Los Angeles
3.	Webster, S.D.	Electrodialysis	Bureau of Reclamation, Denver
4.	Roswell, N.M.	Forced circulation vapor compression distillation	?
5.	?	Freezing process	?

demonstrated to the interested public at Syracuse, New York, last October. This plant is currently being moved to Wrightsville Beach, North Carolina, where sea water for further experimentation is more readily available. Blaw-Knox is building a pilot plant based upon the Cornell Process to be located at St. Petersburg, Florida. Thus far, the work on this process has been confined to laboratory experiments performed under Professor Wiegandt at Ithaca, New York, all of which has been reported in the literature.

The dark horse in the race is the new Struthers Wells-Scientific Design (SW-SD) Process, just recently revealed. Under the sponsorship of the Office of Saline Water, experimental work on this process that separates fresh water from sea water by first producing pure ice crystals and then separating them by a continuous centrifuging process has been quietly going on for many months at the Struther Wells Corporation plant in Warren, Pa., under the direction of Hans Svanoe—a veteran designer of crystallizers and profitable crystalization processes with a successful experience record of over a quarter of a century.

It's still very difficult to get the details of this process. However, some things are known about it. The importance of the process is the anticipated low over-all cost of fresh water production. This expected low cost of production is said to be based upon the control of ice crystal uniformity, size and growth habit. By closely controlling supercooling, by using a carefully chosen recoverable hydrocarbon refrigerant in direct contact with the sea water, uniform hexagonal ice crystals are produced. Equally important to the economy of the SW-SD Process is an extremely efficient continuous process for separating salt-free ice crystals from the effluent.

No one knows just how well the processes now under consideration by the Office of Saline Water will help relieve the growing water shortages in the U.S.A. Indeed, they may provide our State Department with an attractive lure to induce underdeveloped water-short countries to look to the West. In any event, it looks like the OSW is about to hand the American tax payer a great bargain. Nothing is more important to the U.S.A. than new sources for fresh water. Few consequential government development programs have produced such great prospects for so little money.

—Jos. L. Gillman, Jr.

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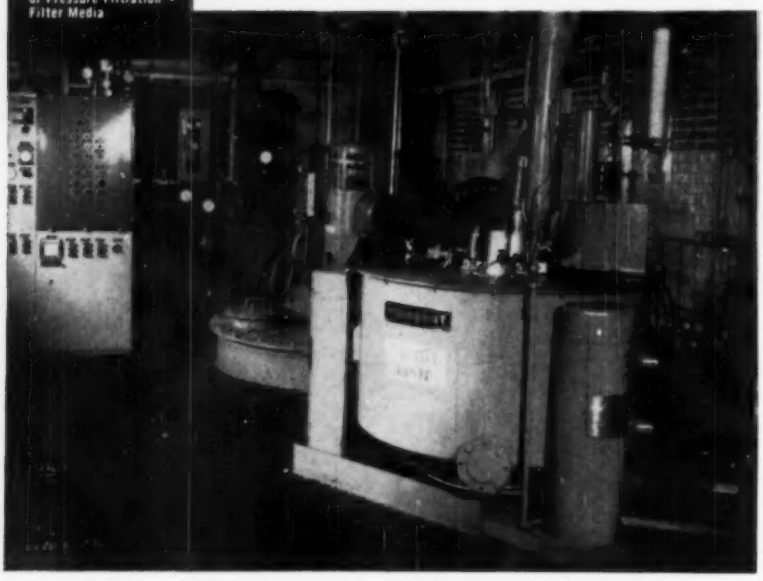

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letters to the editor

April editorial off-base

The editorial comment is interesting, but I venture to suggest that both Dr. Harrison and the editor are somewhat superficial in their analysis. Perhaps I should say instead that I don't believe these comments have local application.

If you know of any mathematicians or scientists who would like to teach school in Akron, please give me their names. If they are seriously interested in such a job, and if they offer some indication of teaching proficiency, we will have no problem of qualifying them for a teaching position. Please note that we are interested in full-time teachers only. Part-time service has never proven at all satisfactory.

Since 1955 we have been pursuing an intensive program of combing all sources for potential teachers. We have hired a vast number with degrees in the arts and sciences, not in education. We have an arrangement with the University whereby we can give these people the rudiments of teaching techniques in a minimum of time. I do not think we are unique in this policy, although I suspect we are more active in pursuing it than in other communities. Dr. Harrison's suggestion, and the editor's blind acceptance of this suggestion, is simply uninformed.

I should like to point out one other factor which Dr. Harrison apparently overlooks. He implies that because the person has subject competence he is qualified as a teacher. This is just not true. How many college teachers do you remember, or do you know, who, although well qualified in their subject field, were any good as teachers? I recommend caution in supporting the viewpoint that scientists and mathematicians are automatically competent teachers.

Dr. Harrison comments about our usual salary schedule and offers no solution. The criticisms of this salary system are equally obvious to all of us who are in the business. Dr. Harrison has not suggested anything that is new to us. We must accept the fact that we on the Board are reasonably intelligent people and would certainly establish a merit system of payment if the problems were not formidable. The suggestion that we

maintain acquiescence simply because of tradition is insulting to those of us who are mixed up in the education business.

P. S. SHERMAN

Operating Manager
Chemical Division
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In addition to his other duties, Reader Sherman is president of the Akron Board of Education, a commendable civic attainment. He takes issue with the editorial as concerns his local situation. Naturally, there are exceptions and the more the better. Unfortunately, space did not permit inclusion of more of Dr. Harrison's remarks. His main theme is for an upgrading of educational offerings, and he suggests two ways. One, the utilization of industry-trained (and perhaps retired) engineering talent, and two, adoption of a merit pay scale in the schools. A third suggestion is for more rigid entry requirements for colleges rather than simply expanding the physical plants. Dr. Harrison's reply will be in July CEP. –Ed.

Computer Abstract Goof

To the Editor

Please note that Equation 1 of Abstract (051), page 88 of the May issue of *CEP*, should read:

$$A\frac{dW}{dZ} + C\frac{dX}{dZ} + W = G$$

C. D. HOLLAND

Professor of Chemical Engineering

We hope the computer does a better job of catching these than our proofreader does–Ed.

Classification not the answer

To the Editor

I have read with interest the published letters entitled "Coded articles" and "Work's in progress" by B. E. Lauer and Rollin D. Morse, respectively. (April, 1960)

I am not going to attempt to discuss what is said in these letters beyond a comment or two.

The use of code numbers to identify and indicate the subject-matter contents of articles is in use in a limited manner in Europe and has been used there for a long time. This practice has not been growing, however, and apparently has not "caught on." Articles are not good, clear-cut, subject-matter units as a class of information and total content (a key to all of the new information) cannot

continued on page 28

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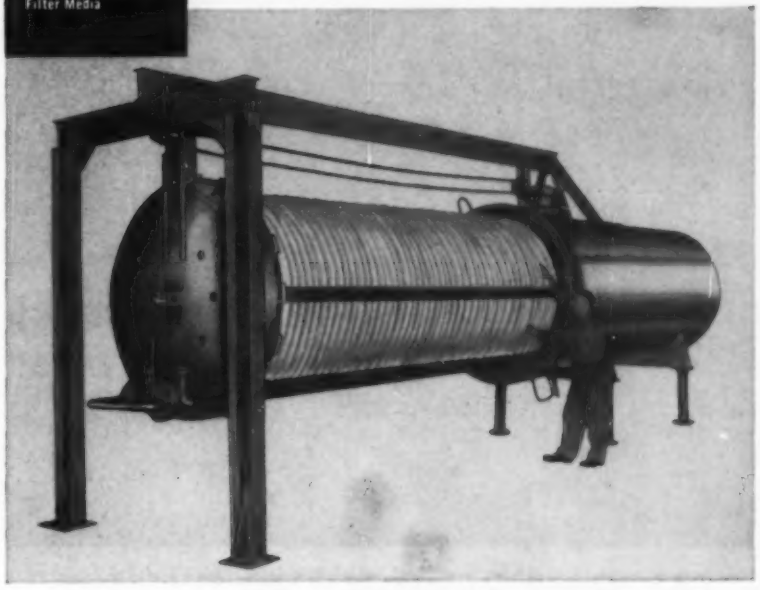

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Letters to the editor

from page 27

effectively be designated by code numbers. A series of new compounds is an example. Furthermore, for effective searching, by means of such numbers either for current information or for information accumulated during a number of years, one would have to have access to hundreds of periodicals and a search would be very time-consuming. Dr. Lauer speaks of a secretary or librarian doing the selecting of articles for review by a technical man. Furthermore we have found that the keying of information can be done much better by a small group of well-informed expert indexers working together with the help of guiding files than it can be done by many thousands of scattered, inexperienced authors.

I agree that standardization of terms is valuable in any field of science or technology, but I do not regard a standard subject-matter list as essential for good indexing. Scientific information is too much alive for that. Standard definitions of terms, yes, but standard key words listed to serve as inclusive subject-index headings, no. The subject indexes to *Chemical Abstracts* avoid unnecessary changes in index headings, but, with cross references to bind things together, the index headings change a good deal (increase and alter) from year to year.

Indexing information (providing a key thereto) is not a matter of classification. Classification helps to a degree, but it is not the objective and too much reliance upon classification tends to destroy the effectiveness of such a key.

E. J. CRANE
Director and Editor
Chemical Abstracts Service

Mr. Crane speaks with a background of 44 years as editor of Chemical Abstracts—ED.

Documentation kits for sale.

To the Editor

For some time now, I have followed the debate in "Letters to the Editor" concerning documentation problems. The most recent spate of correspondence has finally galvanized me into writing you concerning some of the things we are doing.

For the past five years we have been supplying a documentation kit to members of the Society for Nondestructive Testing (SNT) which supplements their six issue per year

journal and microfilm service. The Society markets the kit and receives a commission for each sale.

The SNT kit contains over 400 technical articles beginning with the first issue in 1942 up to the last in 1958. Currently, we are working on 1959 and will issue this as a supplement in the near future. From time to time we hope to issue other supplements such as patents, trade data, and iron curtain literature. When the member purchases a kit, he receives a documentation system ready to go with instructions included and all cards coded and prepunched. Encoded blank cards are available so that a user can enter his own data in the system and still have it compatible with the documentation in this field.

Our system has the interesting virtue of providing a permanent reference source which becomes more valuable as time passes. SNT's set of microfilm of all journals since 1942 now is priced at about what our kit sells for. By no stretch of the imagination can microfilm be considered as an integrated reference system.

Incidentally, we have proposed several systems to magazines where they would offer a kit as a service to their readers.

HENRY N. STAATS
President
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ASQC has its code

To the Editor

Your letter to the editor on Page 26 and 28 of the April 1960 issue of *Chemical Engineering Progress* about coded articles struck a familiar note. The American Society for Quality Control has undertaken such a step as you have suggested and now lists all its papers with the appropriate code. I am asking Mr. G. R. Foster, managing editor of *Industrial Quality Control* to send you a copy of the paper describing the code and suggested method of use. I hope you are successful in your program.

R. S. BINGHAM, JR.
Manager, Quality Control Dept.
The Carborundum Co.

Reader Bingham refers to Dr. B. E. Lauer's letter—ED.

NOTE: The subject of indexing has generated considerable interest within and without the Institute. A subcommittee has been hard at work and two developments are on the horizon: One a thesaurus on chemical engineering; the other a possible combination of abstract and key word list for CEP articles. More on both in later issues—ED.

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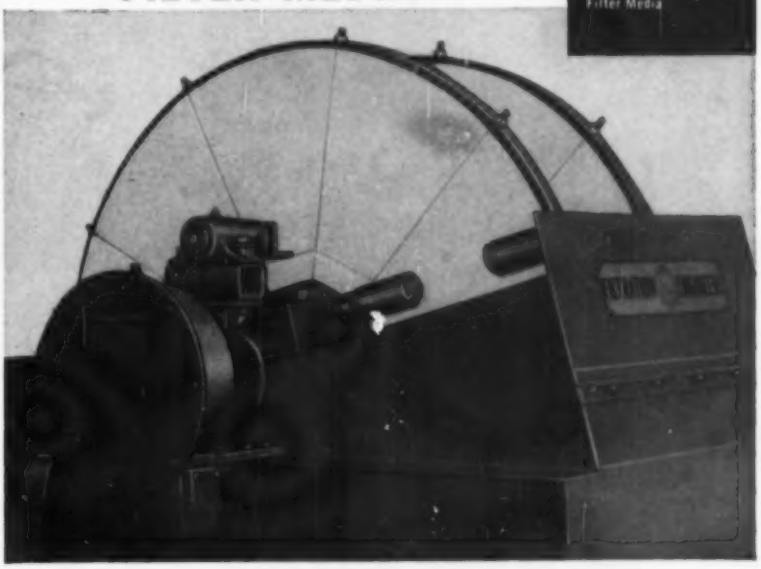

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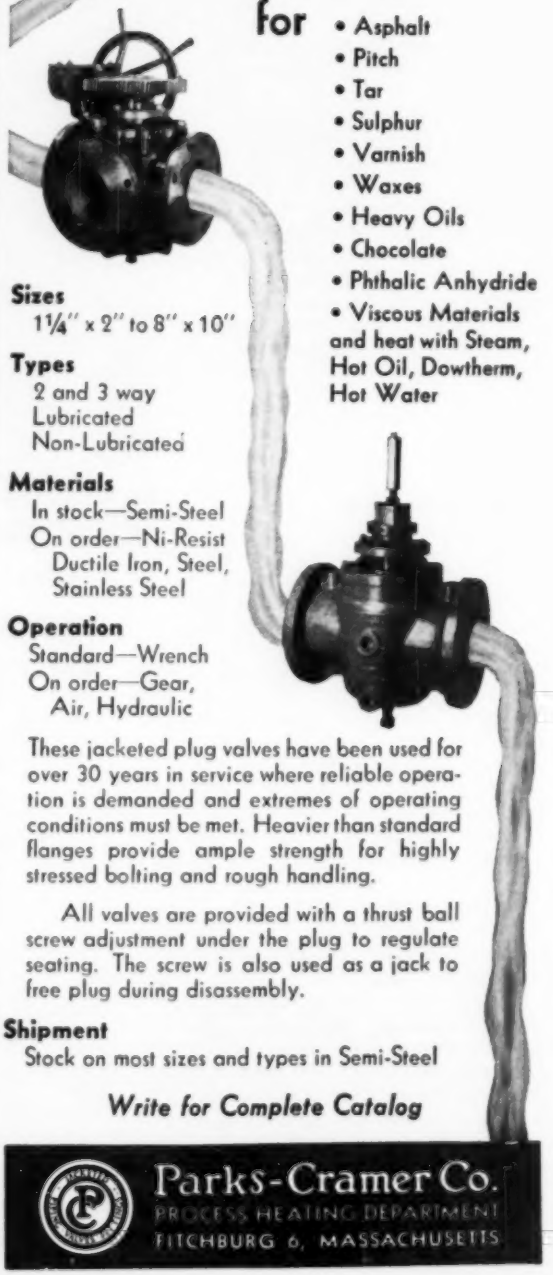

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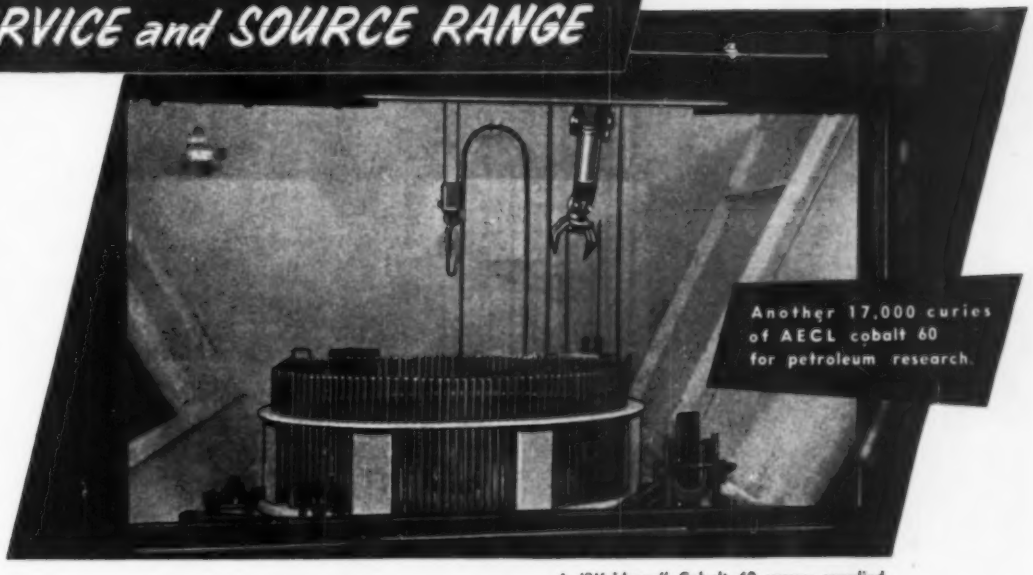

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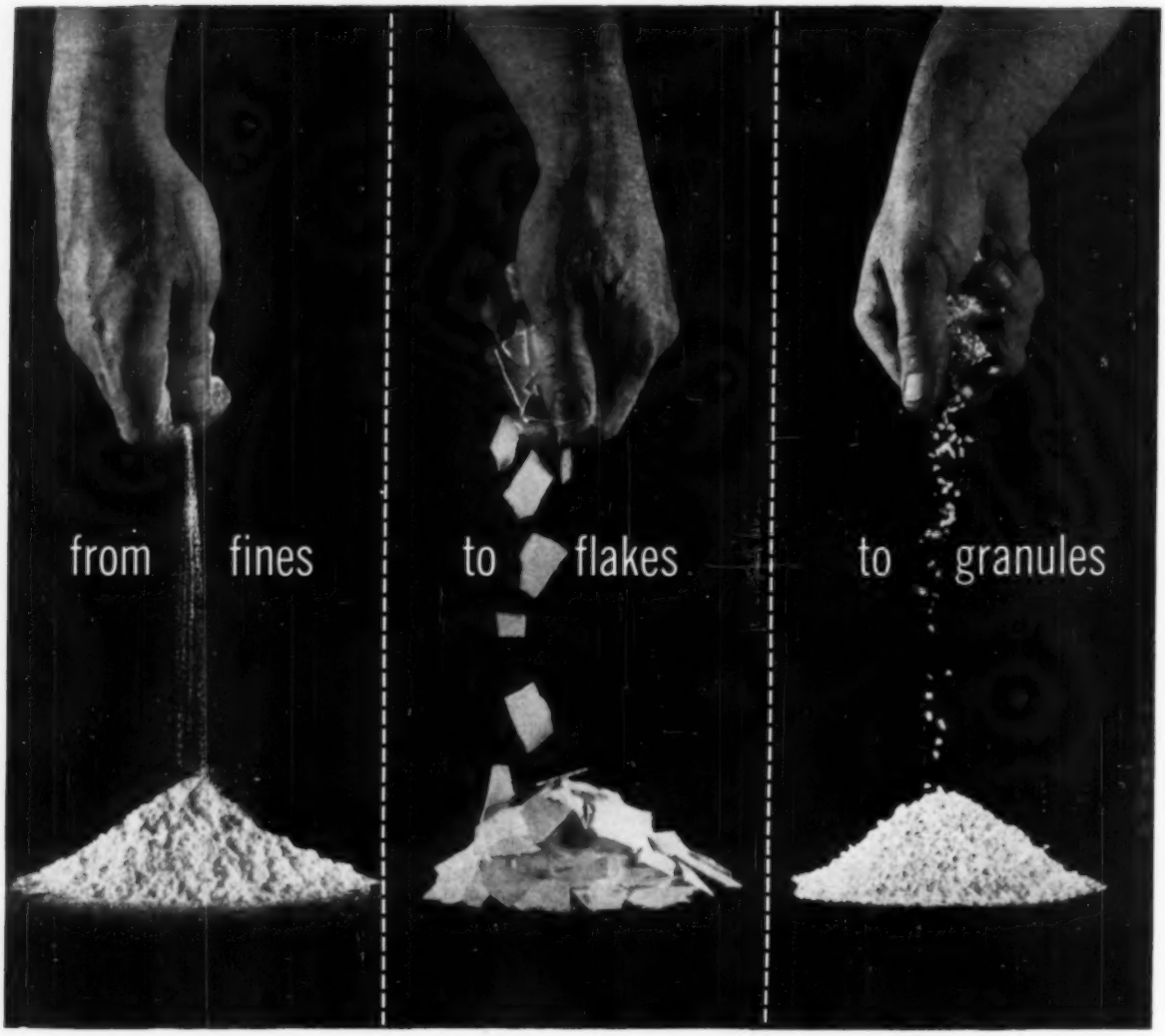

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Is heat a pollutant? Pennsylvania thinks so

THE HEAT'S ON IN PENNSYLVANIA where the Department of Health is proposing regulations for controlling "thermal pollution" of streams. If enacted, industry in the state would have to ante upwards of $100 million for cooling equipment, and then pay about $10 million per year to run it, according to Dr. Richard Hoak, Mellon Institute. Probably, and more important to industry as a whole, legislation in Pennsylvania could set the pattern for the rest of the country.

Parboiled perch

Proponents for thermal limitations on waste water say that warm-water fish don't thrive at 80° F, and temperatures above 93° F are quickly lethal to members of the piscatorial clan. Sometimes the effects can be beneficial by lengthening swimming seasons or improving winter fishing. Effects of discharges can be quite variable, depending on local conditions. Some say that heavy thermal loading of streams is detrimental to downstream industry, since it increases the temperature of water taken off for cooling purposes. Industry, generally, has not been alarmed because plants are designed, where necessary, to cool water by alternate means in the processing scheme.

There is considerable confusion, existing primarily due to a lack of data on the overall problem. This lack accounts in part for the rather sweeping provisions suggested in the Health Department's proposals. They would: 1. Prohibit discharge of wastes, anytime, anywhere, above temperatures of 93° F May-November, or above 73° F December-April. Where streams are suitable for trout propagation no rise in stream temperature would be permitted. 2. Require reduction of heat content of liquid wastes from 35-85%, depending on type of treating required prior to discharge. 3. Require a plant to maintain a fishway not less than ¼ the width of the stream in the affected zone. 4. Have the Sanitary Water Board allocate proportions of the stream to any given user.

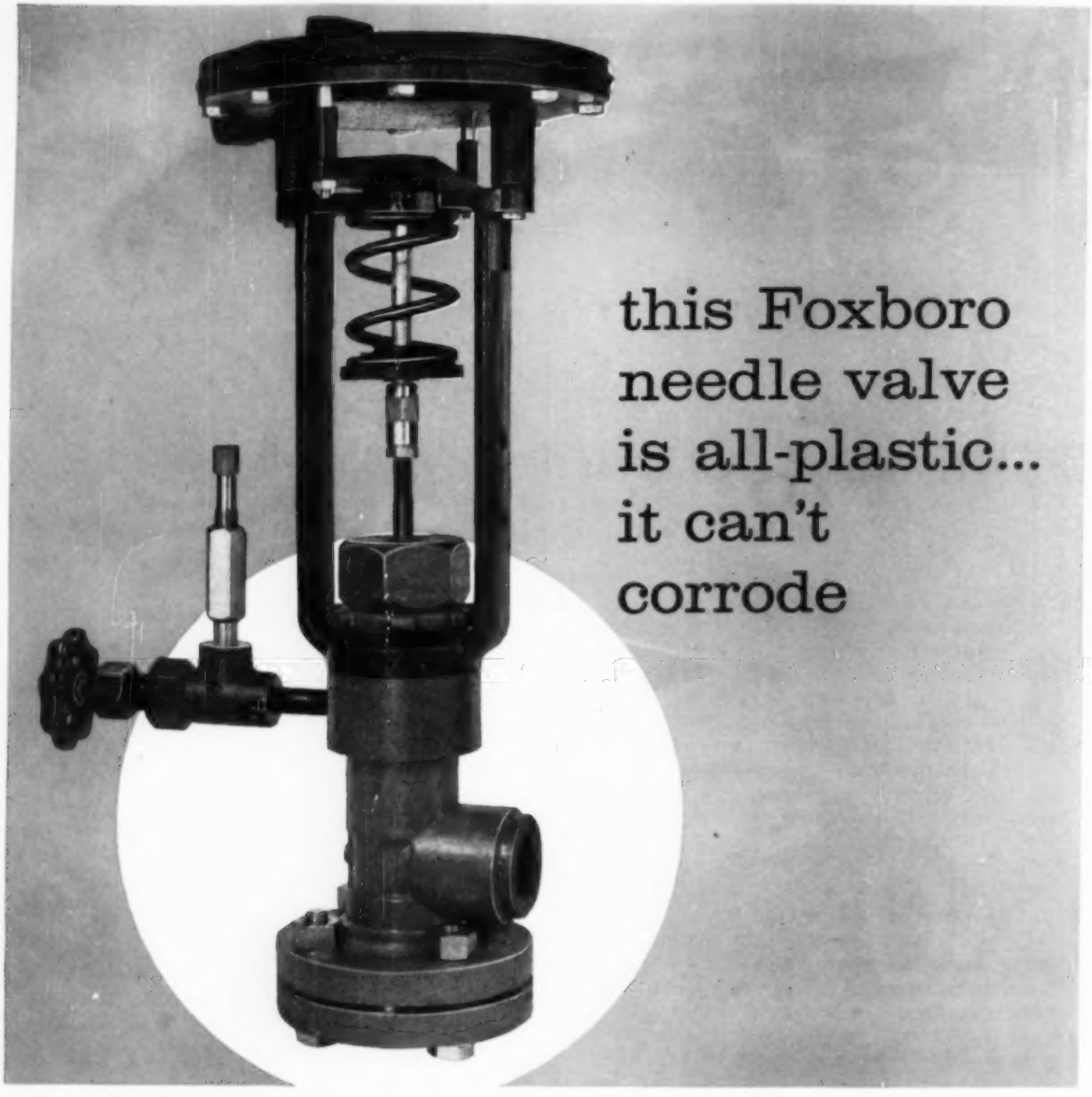
The thought that these regulations might be enacted per se is enough to give a plant manager fits. The proposals leave many questions unanswered: Where to measure the temperature of the outfall? Won't turbulence make a difference? With stratification, couldn't fishways be established beneath the surface? Fortunately, the Department has recognized that the proposed regulations would have to be modified and has appointed an Advisory Committee to discuss the situation and draft a practical set of regulations.

Part of the job of the Advisory Committee will be to gather as much data as possible. This will take time and money, and efforts are being made to have joint studies conducted between industry and the regulatory agency.

How hot is hot?

The advantage of the joint approach is multifold. Basically, industrial organizations usually have trained personnel available for conducting studies. There is no question but that the more data collected, the more objective and rational the conclusions. To this end, it's to industry's benefit that it participate along with agency personnel. Since the law aborning in Pennsylvania may be the prototype for other states, its writing should be of almost universal interest so that practical temperature limitations and controls result.

Finally, there is the question of: Why any law? Perhaps the study will show there's no need for one. But if the record of pollution abatement laws in the country means anything, there's a good chance that the Pennsylvania one will be pushed to fruition. If there's to be one, better industry help in its formative stages than be subject to punitive parboiling itself.



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opinion and comment

Saludos Amigos

THE UNFORTUNATE ASPECT of front page news is its preoccupation with violence. A major effort in promoting understanding between nations will inevitably take second or third billing to minor domestic happenings so long as they have the hallmark of strife. Thus, it should come as no surprise that the joint meeting this month in Mexico City between Latin American chemical engineers and their U. S. counterparts does not command banner headlines in the daily press. Nevertheless, the goodwill generated by the direct contact and interchange of ideas between hundreds of engineers from the Instituto Mexicano de Ingenieros Quimicos and A.I.Ch.E. cannot be underrated.

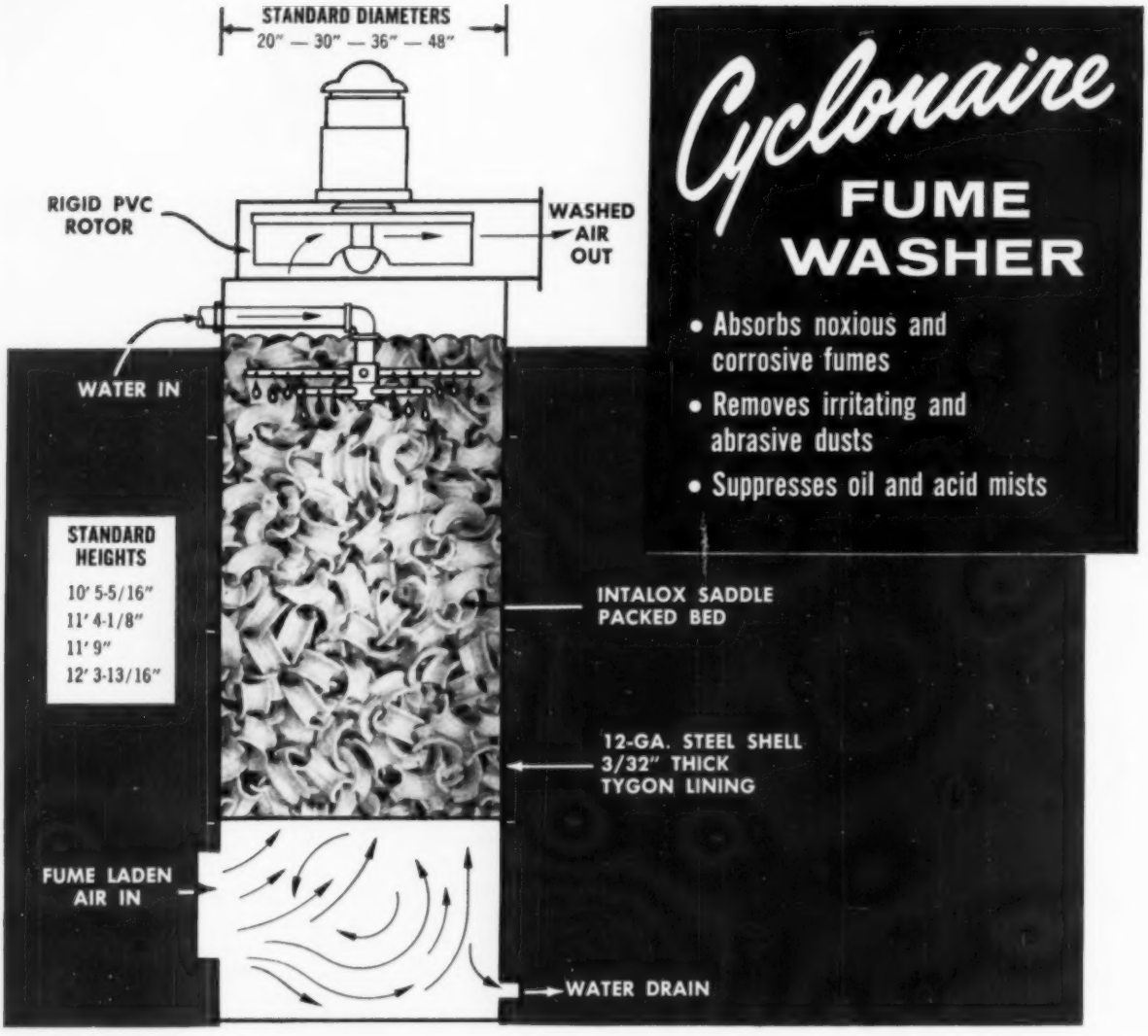
There's a lot more to this business of goodwill than simply the question of fellowship and hospitality, of which there was more than an ample amount at the meeting. From a practical, day-to-day standpoint, there is a mutual—and constantly growing interest between the Central and South American chemical industries and our own. While no two countries are exactly alike in their respective situations, all are typified by the desire and effort to make significant industrial strides forward. As an earmark of their aggressiveness is the high percentage growth in chemicals—both in production and consumption. This issue carries many papers showing the progress being made in these countries.

A feature of the chemical industry south of the Rio Grande is that most of the new plants are based on U. S. processes, a great deal of the equipment was procured in this country, and many are owned and/or operated by affiliates of domestic chemical companies. Companies prominent at home are the same ones active in these countries: DuPont, Dow, Monsanto, Carbide, Grace, Cyanamid, Pfizer, to name a few. Their entry and expansion in Latin American countries is based upon the same good sense which finds so many U. S. companies operating in Europe. Expanding markets, expanding production requires the building of plants within the market area to remain competitive.

A move by a company into a country which they've previously served only through sales outlets is a major operation transcending the relatively simple task of engineering and building a complicated processing unit. Many of the speakers at Mexico City stressed the human factor, which is difficult to evaluate, and upon which the success or failure of a perfectly engineered plant must depend. It is in this area where goodwill means so much. The chemical engineer transplanted overseas is the alien and his attitude — and his family's — towards this new role can make or break the entire project.

As more companies get into the overseas picture and expansion continues at a fast clip, more engineers find themselves having to be half technician—half diplomat. The companies, generally, have done an excellent job in setting up selection and training programs to insure that an engineer and his family will adapt to the new way of life. The biggest job is his own personal transition into the new environment. Hence, too much can't be said about the good engendered by joint meetings between engineering groups. The mutual exchange of technical information through papers breeds a mutual respect for each other's technical competence; the exchange of fellowship breeds an even more important respect for each other as individuals. From the A.I.Ch.E. to the I.M.I.Q., then, we say thanks for the opportunity and Saludos Amigos.

L. R.



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CEP feature

ENRIQUE RANGEL
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The Mexican chemical market

Trend toward fuller domestic industrialization and decentralization accompanies high rate of expansion in Mexico.

A MAIN FEATURE OF THE Mexican market, is its rate of growth, which varies from 10% yr. in basic products to 25-30% in intermediate and finished products. This growth, a characteristic for the last five years, is expected to continue for the next ten in spite of the fact that few marketing techniques have been applied in the past, except perhaps in the field of consumer's products. No market development has been tried, and there are a lot of potentialities that have not yet been explored.

Market surveys and sales research are only recent innovations. Customer service is probably the only activity and this has not been given the proper attention. New product application research is unknown. Advertising and sales promotion are just being started, although usually improperly, especially in foreign companies whose advertising is handled by the foreign office, rather than by the local Sales Department. There are two or three chemical publications where chemicals are starting to be advertised. In this field too, the foreign investor is beginning to realize that marketing procedures in each country are different, and some managerial posts in sales are being filled more and more with technically-trained nationals.

The industry

The chemical industry of Mexico presents the same characteristics noticeable in the architecture. Modern facilities with the latest equipment stand alongside old plants that still produce chemicals using obsolete equipment and processes. The plants are almost completely run by Mexican technical personnel. Skilled labor is not a problem any more, except in some parts of the country.

Until a few years ago, the chemical industry was concentrated near the Federal Districts and Monterrey. Now, as the result of more carefully planned enterprises, new industrial areas are

The Atzcapotzalco refinery of Petroleos Mexicanos refines 100,000 bbl/day of medium and heavy fuels.

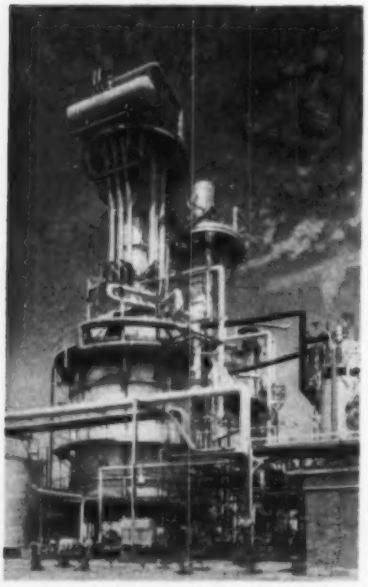
being developed near Tampico, Guadalajara, Salamanca, and Coatzacoalcos.

There are many foreign companies with production plants in Mexico. Most of the outside capital comes from the U.S., however, there are some French, Swiss, and Italian interests. The strong, prewar German chemical industry is coming back, recognizing that there are benefits in having Mexican capital in the financial structure.

In the last few years, many of the facilities were, at least partially, engineered in Mexico. This is being done more frequently all the time, and heavy equipment is commencing to be manufactured locally. In spite of the labor being less expensive than in the U. S., there is a strong trend towards automation. Instrumentation is a fast growing field.

It is also being realized that what is called the "minimum economical size plant" in the States, might be several times smaller in Mexico. Plant size is determined by selecting the best suitable process for local manufacture, rather than choosing the latest process.

As might be expected, the inorganic chemical industry is better developed than the organic. Most of the heavy chemicals are manufactured locally and plans that are being carried out will make Mexico almost self-sufficient in fertilizers and inorganic pigments. The organic industry has developed mainly in the pharma-



Two gas reforming furnaces used by the HyL sponge iron process in Monterrey, Mexico. Courtesy The M. W. Kellogg Co.

Principal Chemicals

Product	1960 Market, Metric tons	Percent of the market supplied by local production	Main Producers
Acids:			
Acetic	400	Overcapacity	Pyrina, S.A. Salicilatos de México, S.A. Industrial Aldos, S.A. Cía. Química Mex., S.A.
Acetylsalicylic	380	Overcapacity	Pyrina, S.A. Salicilatos de México, S.A.
Citric	1500	Overcapacity	Pfizer de México, S.A. Miles Laboratories, S.A.
Hydrochloric	10,000	90	Sosa de México, S.A. Prod. Químicos Mex., S.A. Ind. Quím. Pennsalt, S.A. Ind. Nal. Quím. Farm., S.A.-Others.
Hydrofluoric	750	Overcapacity	Fluor Mex, S.A.
Nitric	5000	Not available	Ind. Nal. Quím. Farm., S.A.
Salicylic	300	100	Pyrina, S.A. Salicilatos de México, S.A.
Sulfuric	250,000	Overcapacity	Ind. Nal. Quím. Farm., S.A Guanos y Fertilizantes, S.A. Monsanto Mexicana, S.A. Alcamex, S.A.-Others
Acetone	2500	Not available	Ing. San Cristobal
Acetylene	5000	100	Aga Mex., S.A. Commonwelth, S.A. Others
Acetic Anhydride	750	100	Industrial Aldos, S.A.
Acetates (inorganic)	2000	None	
Aluminum Sulphate	13,000	95	Alcamex, S.A. Prod. Quím. Mex., S.A. Others
Ammonia	50,000	100 (1961)	Guanos y Fertilizantes, S.A. Fertilizantes de Monclova, S.A. Pemex.
Ammonium:			
Chloride	700	20	Sales Industriales, S.A.
Nitrate	35,000	Overcapacity (1960)	Montrose Mexicana, S.A. Fertilizantes de Monclova, S.A.
Sulfate	120,000	90	Guanos y Fertilizantes, S.A. Cía. Mex. de Coque y Derivados, S.A.–Others
Antibiotics	80,000,000 pesos	None	
B. H. C.	500	100	Scottion Chemicals, S.A.
Calcium:			
Arsenate	2000	100	Diamond Chemicals, S.A. Ind. Quím. Pennsalt, S.A.
Carbide	13,000	Overcapacity	Cía. Prod. de Carburo de Calcio, S.A.
Hypochlorite (HTH)	250	None	
Bleaching powder	360	Overcapacity	Productos Quimicas Mexicanos, S.A.
Phosphate	2600	None	
Carbon:			
Bisulfide	10,000	Overcapacity	Ind. Quím. de México, S.A. Sosa de México, S.A.
Black	10,000	None	
Tetrachloride	275	100	Sosa de México, S.A.

produced in Mexico

Product	1950 Market, Metric tons	Percent of the market supplied by local production	Main Producers
Caustic Soda	85,000	65 (Capacity installed for 80% of the market prod. dependent on chlorine market)	Montrose Mexicana, S.A. Prod. Químicos Mex., S.A. Ind. Quím. Pennsalt, S.A. Sosa de México, S.A. Sosa Texcoco, S.A. Others
Chlorine	15,000	Overcapacity	Montrose Mexicana, S.A. Prod. Químicos Mex., S.A. Ind. Quím. Pennsalt, S.A. Sosa de México, S.A. Others
D. D. T.	1000	100	Montrose Mexicana, S.A. Diamond Chemicals, S.A.
Essential Oils	64,000,000 pesos	None	
Ethyl Alcohol	45,000	Overcapacity	Various sugar mills
Formaldehyde	3000	Overcapacity	Celanese Mexicana, S.A. Catálisis, S.A. Ind. Quím. Formex, S.A.
Freon	500	None	
Glycols	1500	None	
Insecticides:			
Based on DDT	100,000,000 pesos	Not available	Several compounders
Parathion	2000	None	
Dieldrin	1000	None	
Nylon	4000	Not available	Celanese Mexicana, S.A. Celulosa y Derivados, S.A.
Phthalic Anhydride	900	80	Síntesis Orgánicas, S.A.
Phenol	800	None	
Phthalic Ester & Ethers	1500	Not available	Síntesis Orgánicas, S.A.
Phosphate rock	70,000	None	
Polyethylene	5000	None	
Potassium:			
Chlorate	1000	100	Prod. Químicos Mex., S.A. Prod. Quím. Boyle, S.A.
Chloride	10,000	None	
Nitrate	1000	100	Nitro Mex., S.A.
Resins:			
Alkyd	6000	70	Southern Chemical de Méx., S.A. Reichhold Chem. de Méx., S.A. Celanese Mexicana, S.A. Others
Cellulose Acetate	1000	None	
Phenolic	2000	70	Bakelite, S.A. Adhesivos Resistol, S.A.
P. V. A.	4000	100	Celanese Mexicana, S.A. Polímeros, S.A.-Others
P. V. C.	4000	100	Monsanto Mexicana, S.A. Geon de Mexico, S.A.
Styrene	6000	None	
Vinyl	5000	None	
Urea Formaldehyde	2500	80	Casco Química, S.A. Ind. Schwarz, S.A. Adhesivos Resistol, S.A. Others
Soda ash	100,000	50	Sosa Texcoco, S.A.
Sodium:			
Benzoate	200	None	
Chromate	2500	Not available	Cromatos de México, S.A.

continued on next page

ceutical area. Mexico is very strong in the production of steroids, but the petrochemical industry will really give impetus to organic chemicals production.

Markets not filled by local production

The more important local products are discussed here, while the principal chemicals are listed in the Table.

With the exception of nitric acid, Mexico is self-sufficient in acids. Miles Laboratories, in conjunction with a sugar mill, will start operations of a citric acid plant from molasses. The overcapacity of acetic acid, will promote the production of acetates that up to now, are being completely imported to supply the 2000 metric tons/yr. (M-tons/yr.) market.

Acetone is one of the projects that Pemex is considering. They are planning to produce it with cumene at a capacity of 12 million lb./yr. Present acetylene production is mostly used for welding purposes. Pemex is considering a 60 million lb./yr. capacity plant for acetylene.

This year for the first time, the ammonia market should be supplied completely by local manufacturers. Pemex has announced plants with a total capacity of 400 million lb./yr. Ammonium chloride, is partially supplied by only one manufacturer and there are around 450 M-tons/yr. being imported.

There is a very large market for antibiotics, amounting to a total of some 80 million pesos/yr., mainly as penicillin, streptomycin, etc., all of it being supplied from outside. Last year a small plant started producing most of the requirements for 16% gamma BHC.

There is a market of around 250 M-tons/yr. for high test $Ca(OCl)_2$ that up to now is being imported. There is a local manufacturer of bleaching powder. Calcium phosphate is imported at a rate of 2000 M-tons/yr., with no local production.

Imports of carbon-black amount to some 10,000 M-tons/yr. Some announcements have been made referring to local production but none has been definite.

The caustic soda and chlorine markets present a peculiar picture. Chlorine production is large in Mexico, and electrolytic plants cannot produce at full capacity, so, some 35,000 M-tons of caustic soda are being imported. The situation should change as soon as more markets for chlorine are developed, especially by the petrochemical industry, causing the caustic imports to be greatly reduced.

Principal chemicals produced in Mexico

continued

Product	1960 Market, Metric tons	Percent of the market supplied by local production	Main Producers
Glutamate	100	None	
Hydrosulfite	600	100	General Products, S.A.
Hypochlorite	1400	Overcapacity	Ind. Quím. Pennsalt, S.A. Prod. Químicos Mex., S.A. Sosa de México, S.A. Ind. Nal. Quím. Farm., S.A.
Nitrate	9000	None	
Sulfate	25,000	Overcapacity	Sulfato de Viesca, S.A. Celanese Mexicana, S.A. Sales Industriales, S.A. Others
Sulfide	3000	70	Ind. Nal. Quím. Farm., S.A.
Thiosulfate	900	80	Ind. Nal. Quím. Farm.,
Tripolyphosphate	30,000	Overcapacity	Monsanto Mexicana, S.A. Hooker Mexicana, S.A.
Sulfur	Not available	Overcapacity	Several sulfur companies
Solvents:			
Benzene	3000	80	Cía. Mex. de Coque & Derivados, S.A.
Toluene	6500	10	Cía. Carbonífera de Salinas, S.A.
Xylene	2000	10	Cía. Carbonífera de Salinas
Ketones	1500	None	
Titanium Dioxide	4500	100	Du Pont, S.A.
T. E. L.	4000	None	
Vitamins	20,000,000 pesos	None	
Xanthates	800	100	Ind. Químicas de Méx., S.A.
Urea	9000	None	
Zinc:			
Ammonium Chloride	400	70	Sales Industriales, S.A.
Chloride	700	30	Sales Industriales, S.A.
Hydrosulfite	300	100	General Products, S.A.
Oxide	8000	100	Oxidos de Zinc, S.A. Oxidos Progal, S.A. Others
Sulfate	600	Overcapacity	Mexicana de Zinc, S.A. General Products Others

Almost no essential oils are being produced in Mexico. They represent a market of some 65 million pesos/yr. Du Pont has been planning a Freon plant near Tampico that should supply the 500 M-tons/yr. market of this product. Imports of glycols amount to some 1500 M-tons/yr. with no local production.

Montrose Mexicana and Diamond Chemicals are producers of DDT. But insecticides worth around 100 million pesos/yr. are still imported. There is a parathion market of around 2000 M-tons/yr. and the sales of Dieldrin amount to some 1000 M-tons/yr.

Celanese Mexicana produces nylon 6 and Celulosa y Derivados, S.A., in Monterrey are building facilities to produce nylon 6 and 66 to cover the 4000 M-tons/yr. demand. No local production exists for the 800 M-tons/yr. demand of phenol.

Síntesis Orgánicas, S. A., the only phthalic anhydride manufacturer, is also getting ready to produce phthalic esters. Pemex is considering a polyethylene plant with a capacity of 15 million lb./yr. that should cover all the market.

Although some deposits of phosphate rock have been found in Mexico, this is imported at a rate of 70,000 M-tons/yr. The same can be said of potassium chloride with a market of 10,000 M-tons/yr. Soda ash is only being produced by one company and some 50,000 M-tons/yr. are imported. Two companies are considering producing soda ash, one using the salt domes in Coatzacoalcos, and the other, deposits near Monterrey.

Some resins are made in Mexico,

Chemical by-products plant of American Smelting and Refining Co.'s Rosita, Mex., smelter.

Enrique Rangel has a BS degree both in chemical engineering and in chemistry from the University of Mexico. His MS in chemical engineering was granted from Rice Institute, where he studied on a fellowship. He also traveled in Europe on a six months scholarship from the University of Mexico and the European Chemical Industry. Since 1956, he has been with Dow Chemical. He is now head of the Research and Development Department of Dow in Mexico City.

but the monomers are still being imported to supply the 5000 M-tons/yr. demand of PVC, and the similar size markets of PVA and polystyrene. No sodium benzoate is being manufactured to supply the 200 M-tons/yr. demand. The same can be said for the 100 M-tons/yr. market of sodium glutamate. At the present time around 9000 M-tons of sodium nitrate are imported a year.

Pemex has announced the construction of a Udex plant, to produce aromatics at a rate of 75 million lb./yr. of benzene, 200 million lb./yr. of toluene, and 140 million lb./yr. of xylene. Around 1500 M-tons of ketones are being imported with no local production.

Du Pont just finished a titanium dioxide plant that should completely supply the 4500 M-tons/yr. market. Around 4000 M-tons/yr. of tetraethyl lead are being imported. Plans are already being made by several enterprises to supply the market.

Vitamins are all imported to supply the 20 million pesos/yr. market. A Stauffer subsidiary will produce xanthates, to cover the 800 M-tons/yr. demand.

As can be seen, there are several chemicals that offer sizable markets and that could be manufactured in Mexico. This review covers only the most important products.

In conclusion, consider the petrochemical industry. This has been the most talked about chemical theme for the past year. As is probably known a law was passed in November 1958 preventing the granting of concessions to private enterprises for the production and utilization of natural hydrocarbons; and stating that Pemex will be the only producer of all the basic and intermediate petrochemicals necessary for further processing by private industries. The first official list of products to be manufactured solely by Pemex was recently published covering: ethylene, polyethylene, propylene, polypropylene, benzene, dodecylbenzene, toluene, xylene, styrene, butadiene, methanol, isopropanol, ethylchloride, ethylene dichloride, cumene, & ammonia. Some plants are already under construction to produce ammonia, toluene, benzene, and aromatic solvents.

Some markets for petrochemicals are starting to grow to sizable volume to make worthwhile the considering of manufacturing plants. Among them are methyl chloride, chloroform, ethylene chloride, methylene chloride, etc. Some private enterprises, have already turned over to the official Commission projects for the manufacture of some products that will decide the role of Pemex in this industry. At any rate, optimism is high in Mexico regarding growth of the chemical market and industry at home.

Mexican plant cost estimation

PASCUAL LARRAZA
Sintesis Organicas S.A.

Evaluation of project investment, a complex problem in Mexico, depends on careful estimation of process equipment costs, both domestic and imported.

SUCCESSFUL ESTIMATION of investment costs for process equipment has been, and is, a complex problem to solve in Mexico. The reason for this complexity is that, at the present time, there is not a sufficient number of companies properly organized for the fabrication of equipment which has been predesigned and which is subject to the codes and specifications required in each case.

As a result, a large part of the equipment installed is imported. This makes it necessary to coordinate the development of the proposed project from the start, and to make estimates of capital investment for the equipment which must be imported as well as for that which will be fabricated locally.

Obviously, the preliminary work in the promotion of a project will consist basically in making an estimate of capital investment for process equipment, since this investment, in the majority of cases, represents the greatest percentage of the total cost of the project.

The procedure employed for evaluating the over-all investment costs consists in estimating the costs of the process plant, utilities, and distribution.

Process plant costs

Process plant costs are estimated by subdividing the plant process into major components and estimating costs for each.

Equipment cost. The cost of the equipment f.o.b. plant involves consideration of the following partial costs:

1. Project engineering. The cost of project engineering is proportional to the amount of the investment and consists of salaries of the technical personnel involved in working on the project. Mattozi (*1*) considers that project engineering alone takes approximately 1500 man hours for each 100,000 U.S. dollars of equipment and materials. The function of project engineering is to group together the work done by the various specialists working on particular phases of the project: process, design, instrumentation, specifications, *etc.*

2. Purchasing. Purchasing departments in design and construction firms have the responsibility of purchasing, fabrication supervision, loading, shipping, *etc.* of the equipment for the project. The consumption of time by this department is of the order (*1*) of 100 man hours for each

100,000 U.S. dollars of equipment investment cost.

3. Equipment cost. Once the capacity of each piece of equipment has been determined by the technical personnel involved in design and project engineering, the cost of the equipment is estimated from the usual tables, by direct quotations, or by corresponding cost indices (*3, 4, 5*).

4. Royalties, commissions, consulting fees, *etc.* In some projects it becomes necessary to use patents, processes, or systems which are the property of some private company. In this case, an additional contractual charge must be considered within the equipment cost to cover the value of the service required.

As a general guide, Table 1 shows the relative costs of equipment f.o.b plant based on an equipment cost index of 1 in the United States. These figures are compared with average values for equipment imported from Europe.

Equipment erection costs. The equipment, purchased and in place in the plant, has an erection cost divided into two parts. These are:

The San Rafael mill of Cia. de las Fabricas de Papel de San Rafael y Anexas, S.A., the oldest and largest paper mill in Mexico.

1. Foundation and anchoring costs. Depending on the size and weight of the pieces of equipment, it may be assumed that foundation costs are of the order of 250 Mexican pesos* per square meter of area cemented. The variation, depending on soil conditions, is plus or minus 20%.

2. Erection costs. The cost of erecting the pieces of equipment depends on their size, weight, and height. A reasonable average is 500 Mexican pesos/ton, with variations of plus or minus 15%.

Instrumentation costs. A modern plant requires proper instrumentation which will be reflected in better quality control. The required instruments must be located at the critical points of the process and, for this reason, plant instrumentation will vary according to the number of key points

* Money conversion rate: 12.5 pesos = $1 U.S.

Table 2. Typical labor costs for installation of

Size	1/2	3/4	1	1 1/4	1 1/2	2	2 1/2
Material:							
Piping (length)	2.35	3.00	3.50	4.10	4.50	5.40	6.10
Flange	7.50	10.40	11.40	13.00	14.60	17.40	19.80
Reducer	9.00	11.40	13.50	15.60	17.40	20.60	23.60
Elbow	12.80	16.20	19.40	22.00	24.60	29.20	33.40
Globe valve*	13.80	17.60	21.00	23.90	26.70	31.80	36.30
Gate valve*	13.80	17.60	21.00	23.90	26.70	31.80	36.30
Safety valve*	12.60	16.00	19.10	21.80	24.30	29.00	33.00
Check valve*	12.60	16.00	19.10	21.80	24.30	29.00	33.00
Trap*	12.60	16.00	19.10	21.80	24.30	29.00	33.00
Strainer*	9.00	11.40	13.50	15.60	17.40	20.60	23.60

All costs in Mexican pesos.
**Includes price of connection.*

Table 1. Cost comparison of imported equipment.

	United States	Europe
Equipment price	1.000	0.900
Engineering	0.080	0.060
Purchasing	0.004	0.002
Royalties, *etc.*	0.050	0.050
Transportation to Mexico	0.010	0.030
Equipment f.o.b. plant	1.144	1.042

which must be controlled. It may, nevertheless, be assumed (2) that the average cost of instrumentation is of the order of 20 to 25% of the value of the equipment f.o.b. plant.

Cost of piping and connections. The cost of piping and connections always represents a large percentage of the total cost of the project. It can easily consume (6) up to 60% of the total engineering man hours assigned to erection and can represent up to 100% of the cost of the equipment.

In Mexico, the cost of piping installed in American dollars can be estimated in the following manner:

Cost of piping and connections = (U.S. cost) × 1.42

Erection cost = (U.S. cost) × 0.53

It is evident that the cost of the piping and its connections will depend on the type of process and its capacity.

Table 2 can be considered as a representative average of wage payments for the erection of carbon steel piping (Schedule 40).

Structures. Depending on the function of the structures for installation of the pieces of equipment, it can be assumed that in Mexico a reasonable average cost is 5000 Mexican pesos per ton installed. This price includes structural design, materials, anchoring, painting, and labor. With respect to the cost of the equipment f.o.b. plant, it can be estimated that the investment for structures represents 15%.

Buildings. The average unit cost for industrial construction in Mexico is 450 Mexican pesos per square meter. Based on the cost of the equipment f.o.b. plant, this represents 5% for outdoor installations, 12 to 15% for mixed installations, and 20 to 30% for indoor installations.

Electrical installations. Excluding the cost of motors, the electrical installation, depending on specific demand in each case, represents an investment cost of approximately 1000 Mexican pesos/kw. This figure includes the following: engineering, substation, armored cable, secondary lines, switches, contacts, *etc.*

Utilities costs

Other plant utilities for which cost estimates are made are steam and water.

Steam plant. The investment required for an installed steam generating plant is approximately .30 Mexican pesos/1000 Btu./hr. This cost includes the steam generator, instrumentation, boiler, fuel and water feed systems, condensate return system, ash removal, stack, connections, and labor.

Water system. In consideration of the water system, which will be different for each process, we may set up the following:

1. Well.—1000 pesos for each meter of depth.
2. Deep well pump.—1000 pesos/100 gal./min. (installed).
3. Elevated tank.—200,000 pesos/100 cubic meters (installed at a height of 40 meters).
4. Cooling water towers (induced draft).—25,000 pesos/100 gal./min. (installed).

Distribution costs

A third cost considered in this analysis concerns distribution costs.

Storage system. For liquid storage, the investment for tanks can be estimated with a variation of plus or minus 10% by using Chilton's correlation (4). These tanks are fabricated and installed in the country. In the case of storage of granulated solids, we can use the costs estimated previously under buildings.

Internal communications. Space for internal transportation and services is normally paved with asphalt or concrete. An average cost for paving can be estimated at 20 pesos/square meter.

piping in Mexico.

3	4	6	8	10	12
6.90	8.10	10.40	12.50	14.10	15.60
22.20	26.30	33.60	40.00	46.00	51.00
26.30	31.30	40.00	47.50	54.50	60.00
37.30	44.50	56.50	68.00	77.50	86.00
40.50	48.00	61.50	73.80	84.00	93.00
40.50	48.00	61.50	73.80	84.00	93.00
36.90	43.80	56.20			
36.90	43.80	56.20			

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Staffing overseas operations

The continued success of any business enterprise today depends on able staffing. The growing size and importance of overseas investments, and the complexity of the economics and operating problems which they represent, have accentuated the need to staff these operations with qualified individuals. The human is still the controlling element, not the machinery or technical know-how.

Criteria

The problems encountered in staffing a plant at home also exist abroad, but in addition, there are special qualifications which overseas personnel must possess or develop. Four basic qualifications which a company should insist on in the men it selects as overseas managers without regard to national origin are:

1. Technical and/or administrative ability. The latter includes skills in organization, finance, and human relations.

2. Ability to understand the culture and traditions of the people of the country; finding out what motivates others to think and behave as they do.

3. Ability to adjust to different climates, foods, social customs, and other situations. Though knowing the language is no guarantee of overseas success, a willingness to learn to converse above the tourist level indicates a desire to know the people better and can contribute to the area of mutual understanding and appreciation.

4. The conviction that the U. S. enterprise abroad must become a part of, and contribute to, the community and the economic system. Organizational structure and procedures need not be an exact image of a state-side operation. Nevertheless, the management thinking and organizational disciplines must aim at the same goals as the parent company, and be based on the American system of private enterprise and personal freedom.

Overseas venture

Monsanto began its first overseas venture in 1920 when it acquired an interest in a chemical company in North Wales. This investment has since expanded into Monsanto Chemicals Ltd., a multimillion dollar company with over 4000 employees. Today, Monsanto has manufacturing activities in 11 foreign countries and sales representatives in 71. Of the more than 7000 overseas employees, 600 hold university degrees: about 330 in chemistry or chemical engineering and the remainder mainly in business, law, and other types of engineering.

Protecting stockholders

It is a basic Monsanto policy that its overseas investments be managed and operated for maximum profitability and use to the fullest extent the nationals in each country. These operations must also integrate into, and contribute to, the growth of the local economy by producing what the country needs and by using local raw materials as much as possible. The choice and proper training of personnel are the keys to the successful implementation of this policy. Company policies and practices are not rigid. They are constantly evolving and improving.

Richard N. Augustson received a BS and MS from Iowa State University. Currently area development manager (Latin America) for Monsanto's Overseas Division, Augustson is located at St. Louis. He joined Monsanto in 1951, at the Mound Laboratory in Dayton, Ohio, then served with the Inorganic Development Department. Augustson was overseas from 1956 to 58, with Monsanto Chemicals, Ltd. in Ruabon, Wales, and London, England.

Since Monsanto's overseas operations are based, generally, on existing Monsanto process technology, it has been the practice to have U.S. personnel supervise the construction and start-up, and be present when key personnel are being trained. U.S. personnel on loan from the parent company for this purpose normally work with the overseas company for specific (usually short) periods and are withdrawn as soon as possible. For example, Monsanto Mexicana now has 230 employees, including 22 chemical engineers. The U.S. personnel used at the beginning have all been withdrawn. Today, the entire operation is managed and run by Mexicans.

In the countries in which Monsanto now operates (mainly highly developed ones), Monsanto has been able to fill practically all key positions with local people of demonstrated ability. As a result, problems seldom arise pertaining to its relationship with the local workers.

This maximum use of nationals is desirable because it promotes better morale in the organization and readier acceptance of the local company in local eyes, and, of course, there are also economic factors. But from the most practical standpoint, a company cannot overlook any source of competent personnel. There are not enough anywhere to go around.

Overseas division

The Overseas Division of Monsanto, through its administrative, sales, development, and other departments in St. Louis, now provides the machinery required for the major functions of the division—the export of domestic products to overseas markets, and the support and control of overseas manufacturing. About 20 persons in the division are directly concerned with the management, control, and expansion of Monsanto's overseas investments, and there are less than 20 other Americans now working for Monsanto outside the United States.

The management of every Monsanto plant or separate company is trained in Monsanto methodology and must conform to certain company-wide practices and standards of performance. Within each function of the company, such as manufacturing,

sales, or research, there are certain criteria used in considering the allocation of management effort. For example, the four fundamental criteria used in the manufacturing sector are safety, quality, quantity, and cost. There are also basic Monsanto standards for marketing, market development, and research.

Technical liaison and travel are continuous and extensive between Monsanto, U.S. and its operations overseas. The people chosen to operate these plants, generally, are trained in the U.S. and thereafter frequently attend production, sales, and research conferences, and company-wide executive management sessions. Overseas management people regularly visit Monsanto headquarters in St. Louis and have available to them the experience and know-how of the entire Monsanto organization.

There is also a constant stream of technical information and reports flowing both ways, which not only keeps these companies up-to-date on the latest process improvements and new developments, but also allows St. Louis headquarters to gauge the performance of each overseas management. Reports of special interest to U.S. management are the five-year development and cash forecasts.

As a result of its methods of selecting, training, and supporting its overseas personnel, Monsanto is able to operate with a minimum number of U.S. management, technical, and sales personnel living abroad on medium to long-term assignments. In the management category there are four such individuals. In France, an American is Manager of Technical Service in the associated company, Monsanto-Boussois. In Japan, an American is assigned as Director and Vice President of another associated company, Mitsubishi-Monsanto. An American is serving in Argentina as assistant to the General Manager of Monsanto Argentina. In all cases, however, top management responsibility still is in the hands of a President who is a national of these countries.

Most recently, a position of European Director of Monsanto Overseas was established to represent the company in that area.

In the past, about five other Americans have held positions overseas as Managing Directors or Assistant General Managers. They have since been succeeded by qualified local people.

In the technical category, Monsanto now has six Americans living overseas. For example, a production expert is on loan to Monsanto Chemicals Ltd. in England, and a research specialist was recently transferred to the North Wales plant. This man serves as technical liaison with the Research Dept. in St. Louis and also directs a research group working on long-range projects. A Plastics Division research chemist has been assigned to Monsanto Chemicals of Australia to direct Research & Development.

On the European continent, Monsanto maintains two technical people as European technical representatives who function primarily to uncover and acquire new technical know-how for Monsanto. These representatives report directly to St. Louis. Monsanto has also established a laboratory in Zurich where a group of European scientists conduct fundamental research. This laboratory is directed by an American.

Finally, in the sales category, Monsanto now has seven Americans living abroad, each on a long-term basis. Offices have been established in Paris, Geneva, Tokyo, Sao Paulo, San José, Costa Rica, and in Puerto Rico. In most cases these men are commercial representatives who report to U.S. headquarters and whose primary function is to instruct, and assist local sales agents.

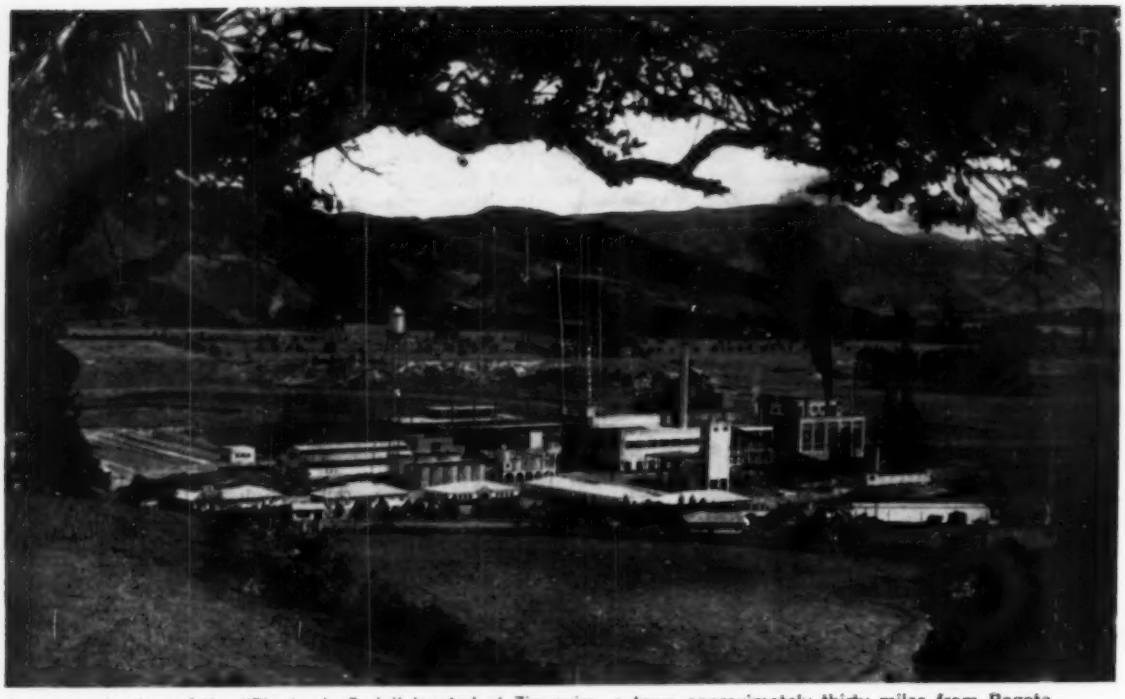
In summary

This brief description has summarized the policy and methods which Monsanto has developed over the years for staffing its overseas operations. In general, it can be said that Monsanto supervises its overseas operations indirectly by sound training in its methods, and directly by reports and inspections. As has been emphasized, however, company policies, particularly personnel policies, must be flexible.

Monsanto is confident that its system of personnel selection, training, and control protects the over-all interests of the company, and provides the best atmosphere for the growth and development, both of the companies and of the individual employees. And not the least gain is that such policies help to present American free enterprise in the best possible light.

Figure 1. Monsanto Argentina, at Zarate, Buenos Aires, manufactures polystyrene, PVC, phthalic anhydride, and plasticizers.

Figure 2. Monsanto Mexicana, at Recheria, near Mexico City, produces polystyrene, PVC, sodium tripolyphosphate, sulfur, and phosphoric acid.



A panoramic view of the "Planta de Soda" located at Zipaquira, a town approximately thirty miles from Bogota.

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Chemical development in Colombia

Rapid growth and changing economic conditions add to the inherent technical problems of the small-scale industries of Latin American countries.

Colombia has felt the need to industrialize at a rapid rate to overcome the serious economic impact of reduced prices for their main exports. In the last twenty years, the country has come from a very small beginning in the chemical industry to the operation of an important nucleus involving production amounting to 100.7 million dollars. The over-all chemical growth rate from 1950 to 1957 has increased by a factor of 400% in relation to its output. In a sense, an analysis of Colombian chemical industry illustrates the general principles and inherent difficulties which apply to the development of new ventures in so called under-developed economies.

Colombia is well supplied with different raw materials. The country has the largest coal deposits in South America, and shares a good part of the continent's oil reserves with Venezuela. In addition, both salt and limestone are readily available for the production of soda ash, caustic soda, and other soda derivatives.

Power production in the country amounts to 2.99 billion kw-hr., with new developments underway to increase this by 30%. Industries requiring large amounts of electricity have not yet developed. However, in cases where power represents a small proportion of the total production cost, it will be readily available in the near future.

As a guide for further discussion, Table 1 illustrates the costs of different services in Colombia. Most of these costs are higher than in the United States, with the exception of labor. This is advantageous for certain industries, but is not beneficial when production efficiency is sacrificed for larger employment of local labor.

Cost data for different raw materials per metric ton are:

Salt, industrial	$ 15.00
Coal, delivered	$ 5.00
Sulfur	$ 46.00
73% Caustic soda (dry basis)	$100.00
98% Sulfuric acid	$ 60.00
Chlorine (gas)	$ 40.00

The high costs reflect the effect of capacity in the smaller plants.

Table 1. Costs of various services in Colombia.

Power	US $0.005-0.01/ kw./hr.
Water (Treated)	US $0.15/1000 gal.
Steam	US $1.00/1000 lb.
Unskilled labor	US $0.30/hr.
Skilled labor	US $0.50/hr.
Transportation:	
Truck	US $5.10/ton/100 mi.
Railroad	US $5.00/ton/100 mi.
Capital interest rates	8-10%
Income tax (Net income before taxes, over U.S. $780,000)	32%
Excess-profits tax (over 50%)	51½%
Property tax (over U.S. $1,000,000)	1.4%

Soda ash production

One important chemical industry in Colombia is the production of soda ash using the Solvay process. A basic industry such as this tends to point up some of the problems associated with relatively small-scale operations and unpredictable demands in a rapidly expanding economy.

Two important factors in soda ash production are the salt conversion efficiency and ammonia recovery. The first depends mainly on the contact equipment between the CO_2 and the ammoniated brine. Due to the low absorption efficiency of the CO_2, the well known tall Solvay towers are required at a very high initial cost. The second, the recovery of ammonia, is important since losses represent a high proportion of manufacturing costs, particularly in an area where ammonia is not produced on any appreciable scale.

Normal figures stated in the literature indicate a normal loss of from 1 to 2 lb. NH_3/ton of $NaHCO_3$ and a salt efficiency running from 74% to 76%. These figures are generally quoted for plants producing about 1000 tons/day of soda ash. It is generally accepted that the minimum operating plant should have a capacity of at least 150 to 200 tons/day. The soda ash plant actually in operation in Colombia has a nominal capacity of 100 tons/day and the losses of ammonia are at least 200% higher than those in larger units. Salt efficiencies of 72% have been maintained.

Special care must be given to those operations which correspond to the larger proportion of ammonia losses. The bicarbonate filters are one of the large sources of losses, especially at the blowing period of the filter. In large plants, several units are usually installed in this phase, while in small plants it becomes necessary to work with a minimum number of units. The filtering process is one step which represents a special difficulty whenever abnormalities exist in the process. Therefore, sufficient extra capacity is required to make up for any changes in the operation of the equipment. Usually, filters are designed with 30% to 40% extra capacity to allow for the cleaning period as well as for irregularities in the size of the crystals, the rate of flow, and other factors.

Another problem exists when the gases from the carbonating equipment are passed through a washing tower which requires a minimum irrigation rate of brine to operate efficiently. Any variation in the distillation of the ammonia is reflected in the flow of brine to the whole system. Changes in the equipment operating rates appear as variations in the efficiency of absorption in the final scrubber, making it necessary to design this scrubber in such a manner as to allow for relatively large changes of the liquid flow rate with no appreciable effect on the absorption efficiency of the tower.

Other typical problems

Another typical problem was encountered in the conversion of bicarbonate into soda ash where indirect fired rotary furnaces are employed. Initially it was deemed economical to use stoker firing with coal, since cheap labor was available. Actual plant operation indicated the opposite point. Although labor may be plentiful for simple operations, continuous firing of three furnaces created several problems. The strenuous effort required in firing forty tons of high ash coal in a continuous manner made this operation impractical. Although close draft controls were established, the frequent opening of the fire doors made adequate air control impossible. The coal consumption increased by 100% over the theoretical. The system was changed to automatic powdered coal firing with excellent results.

A further difficulty which is inherent in the design of equipment for an economy similar to Colombia's is represented by the exceedingly large rate of increase in the demand for basic chemicals during the process of economic development. Such changes are usually completely unpredictable and characterized by rates which may amount to 20% or 30% a year, leaving the designer little hope of getting exact figures on the actual capacity. The actual consumption of soda ash is shown in Table 2.

Plant designers must allow at least 40% additional capacity in buildings and general space to allow for expansion, even though this may not be economical in the initial plant. In addition, multiple unit systems must be considered to allow the necessary flexibility. Since power is not available in large amounts, many plants must have their own generating equipment in order to have ample and continuous

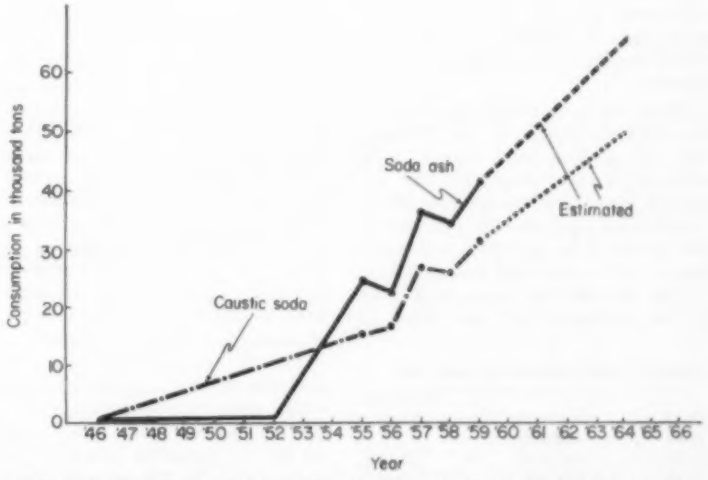

Figure 1. Consumption data for soda ash and caustic soda in Colombia.

supply of power. In general, it is necessary to allow for a 50% expansion in the power facilities to meet future demands.

The soda ash industry is characterized by a very high investment cost, especially represented in cast iron towers required for the different stages in the operation. As the capacity increases, this cost, as is well known, decreases, below a certain limit the actual cost of a plant tends to become stationary. In Colombia's case, for a plant that would produce 100 tons a day, the cost of the equipment including all facilities amounted to 10 million dollars in 1950. This compares to 30 million dollars for a plant of a 1000 tons a day production according to the usual cost figures in the United States.

Caustic soda industry

The development of the caustic industry follows that of the textile and manufacturing industries as shown by the following 1959 consumption figures:

Soap manufacture	30%
Textiles	50%
Petroleum Industry	5%
Other chemicals	15%

It is expected that the caustic industry should increase appreciably with industrial growth and recent developments of large export markets for manufactured textiles. Figure 1 illustrates the increase in capacity that has occurred in the last 10 years. As a comparison, the figures for soda ash are included.

In Colombia, two general procedures are adapted for the manufacture of caustic soda; one uses soda ash as the raw material, and the other is an electrolytic process. No special difficulties are encountered in the design and operation of these plants since their capacities are not much below the usual figures in the caustic industry.

However, some specific problems in the original design of the finishing step to produce solid caustic is of interest. A direct-fired cast iron pot system was used in preference to evaporation equipment to concentrate the caustic from an initial concentration of 50% to the final one of 98%.

This decision was taken as a result of the availability of local labor, as well as that of coal. However, it was found that it would be much more economical to evaporate the caustic directly by the second method. In this case the availability of labor could not compensate for the efficiency of the operation by mechanical means.

Another difficulty observed in the initial operation of the caustic plant was the lack of a continuous supply of steam. A large and continuous quantity of steam is required in a process of this type, and any power failure would be a great problem. Sufficient piping connections are required to be able to drain, at a certain instant, the evaporator containing the caustic which would otherwise freeze. In another problem, steam tracing was given due consideration so as to allow for a down time of at least half an hour without having to unplug the connections. These problems, which are almost nonexistent in the American industry, appear frequently in Latin American industries.

Table 2. Consumption of soda ash.

Year	Tons/year	Increase/ year
1946	122,000	
1952	342,000	30.0%
1956	2,230,000	138.0%
1960(Est.)	4,980,000	30.8%

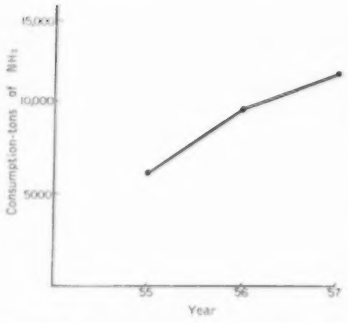

Figure 2. Consumption of nitrogen in fertilizers expressed as tons of ammonia.

Ammonia production

In an underdeveloped economy, most of the consumption of ammonia comes from the use of urea, ammonium nitrate or ammonium phosphate, or other ammonium salts in the manufacture of fertilizers. With a strong agricultural economy, Colombia presently depends to a large extent on the use of imported fertilizers. A project, supported by the government, is in progress for a production of 75 tons a day of ammonium nitrate. The equivalent consumption of nitrogen from fertilizer expressed in the form of ammonia is given in Figure 2.

The relative steadiness of consumption over the last 3 years indicates one of the difficulties occurring in many of the commercial fields which depend on the consumption power of a definite group in the society. Because of the lowering of coffee prices, as well as the increase in the cost of living, farmers have been reluctant to employ fertilizers in the last few years. However, this year it is expected that the consumption of fertilizers should increase again since the original causes for the economic difficulties have been disappearing.

Demand for ammonia allows only a plant of reduced capacity in relation to American standards. In order to allow for improved efficiency, special design has been developed in the converter and the purge gas has been reduced to a minimum by a complete purification of feed gas.

In this industry, a special type of difficulty has arisen since the initial design of the plant was developed around 1948. Financial problems have limited the possibilities of developing this important industry, and only recently definite steps have been taken towards the solution of these financial troubles.

Sulfuric acid

The development of sulfuric acid has not followed the rapid development of the other heavy industries as can be seen in the figures of Table 3. Sulfuric acid is presently being used by the following:

Petroleum Industry	46.6%
Textiles	23.0%
Steel industry	15.0%
Fertilizer	7.7%
Others	7.7%

This industry has been greatly reduced by the small consumption of the fertilizer industry. At this time, there is an excess capacity in Colombia, and some plants are operating at 50% of capacity.

Conventional production units are being employed and no real deviations from the standard design have been applied. However, because of the small size of the equipment, it has become necessary to use special insulation precautions in order to maintain the temperature at the desired levels. Additionally, special characteristics of the sulfur used have made necessary the use of special purifiers to eliminate selenium and tellurium which cause a greenish color in the final product. However, by adequate control of the concentration and temperature of the acid in the towers, it was possible to eliminate this difficulty which to our knowledge does not usually occur in any other sulfuric acid plant employing brimstone as the raw material. This case, as well as the following, indicates the uneven development of the chemical industry in a growing country such as Colombia.

Chlorine and plastics

Special consideration is given to the chlorine problem since it is typical of the Latin American countries where there is a large demand for electrolytic caustic and a relatively small one for chlorine. Chlorine is being used in Colombia mainly in the treatment of water, and to a certain extent as a bleaching agent. Production of vinyl chloride will be started soon and a consumption of approximately 5 to 7 additional tons of chlorine will be used. However, the actual production schedule of electrolytic caustic yields 40 tons/day of chlorine. Therefore, there will be an excess of at least 25 tons/day for several years.

Although the plastics industry has shown an appreciable growth in the last few years, it does not seem possible that these excesses will be taken up by this industry. Research has been directed mainly to the use of hydrochloric acid as a possible source of fertilizer materials. The production of calcium phosphate by treatment of phosphoric rock with hydrochloric acid seems to offer an immediate solution for a large proportion of this excess. It seems that the principal uses of chlorine in Colombia will be in the fertilizer industry and in the paper manufacturing industry. Although several projects are in progress, the amount that may be employed for this purpose would not be more than 10 tons a day.

These conditions give quite a different economic situation than is general in the over-all caustic-chlorine industry. In the United States cheap power exists, as well as an ample demand for chlorine, and therefore the electrolytic method is more economical than the chemical method. In Colombia the chemical process is cheaper. Therefore, future expansions in the field of caustic are being planned through the chemical method and not the electrolytic.

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At the present time, a 5 ton/day plant for vinyl chloride is being designed in Colombia. Although this unit is well below the usual accepted capacity of 20 tons/day, special economic conditions offer an advantage in that chlorine is cheap in relation to most of the materials in the chemical industry. Alcohol or acetylene will be used as raw materials since the demand for petrochemical ethylene would not correspond to economical quantities. Figure 3 illustrates the consumption of plastics per inhabitant in the last four years.

Table 3. Consumption of sulfuric acid.

Year	Tons (98% acid)	Increase/ year
1953	65.3	
1956	65.9	0.3%
1957	77.9	18.2%
1958	98.9	26.9%
1959	100.1	1.2%
1960(Est.)	102.0	1.9%
1961(Est.)	144.0	41.2%

It should be pointed out that the production price for PVC would be higher than in the United States, making it uneconomical to produce it at the rate of 5 tons/day.

A general nationalistic feeling is present in Colombia's economic policies, and the government is prone to increase the import duties on those products that could be produced in the country at costs that can compensate, through the employment of local raw materials for the additional price caused by the inefficiencies of small scale production. Many Latin American countries are following the same steps to insure the growth of their national chemical industries. In the case of Colombia, a 130% bond is required on all imports, increasing the actual cost of the products imported into the country. Usual import duties run at 20% or more of the cost of the chemicals imported. If transportation rates are added to the other costs a 30-40% margin is left for the national production. These considerations have become more important in the last years when Latin American countries have been faced with overproduction of basic export products such as coffee, cotton, and minerals. The interest existing in the formation of regional trading groups will further develop this policy as the expected markets become higher and the production gap smaller.

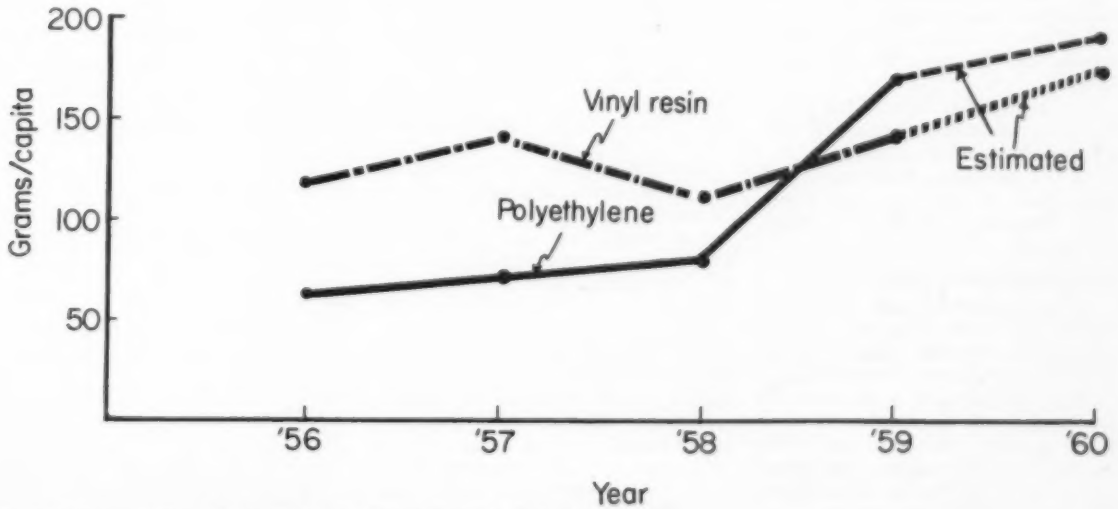


Figure 3. Consumption of polyethylene and vinyl resins in Colombia.

FLORENCIO LARA SOSA
Instituto Mexicano de Ingenieros Quimicos

The Mexican approach to petrochemicals

Here's a survey of Mexico's petrochemical potential, pointing up her crudes, producing zones, and refining centers.

ALTHOUGH THE LOCATIONS of Mexican oil reserves have been known almost as long as have those in the U.S., their development has lagged until early in this century. Carried along by the impetus and know-how of her more industrialized northern neighbor, Mexico is at last attempting to capitalize on her petroleum resources. The following is a resume of what she is doing now, and what she plans to do.

Mexican crude producing zones, refining centers, and potential producing areas are shown in Figure 1. By classifying the various Mexican crudes on the basis of common properties it becomes evident that:

1. The Mexican crudes fall into the asphaltic, paraffinic, and naphthenic groups.
2. Fields containing asphaltic crudes are the most abundant.
3. Fields containing naphthenic crudes are least abundant.
4. There are no fields containing definite aromatic crudes.
5. With a few exceptions, these crudes are traditionally high-sulfur bearing.
6. The asphaltic crudes belong to the subgroup of the asphaltenes, with a few malthenes and carbenes.
7. The producing fields are spread throughout Mexico from the northeast (Reynosa) to the southeast (Tabasco).

Pemex reforming centers

A great petrochemical center will be erected in the Minatitlan refinery around the reforming plants built by Petroleos Mexicanos. To insure satisfactory operation, it is necessary to fractionate and desulfurize the feed to these plants. As a final step in the manufacture of aromatics, Minatitlan will have a plant for the separation of benzene, toluene, and xylenes.

The Minatitlan area will also produce chlorine and H_2SO_4 in quantity while unlimited amounts of natural gas will be available via the new Ciudad Pemex-to-Mexico City gas pipeline.

Pemex has a dodecilbenzene plant in operation in Atzcapotzalco, and in the near future, a plant to produce synthetic rubber will be in operation in Ciudad Madero. A network is being created to integrate the national petrochemical industry.

Petrochemical economics

Certain economic conditions govern the domestic market for aromatics. At the moment, benzene is the only aromatic manufactured in Mexico. It is obtained as a byproduct of the steel industry located in Monclova and Monterrey. The total benzene produced in 1956 was approximately 45,000 bbl. However, in 1958, the demand rose to 135,000 bbl. An idea of the potential benzene market and existing benzene deficit in Mexico may be readily appreciated from Table 1. This deficit will increase within the next two years to as much as 32 million kg/yr. The reforming units in Minatitlan are being erected to satisfy the increasing Mexican demands.

Pemex is now, and will remain, the biggest consumer of toluene. Of the 70 million kg imported in 1958, the largest portion was used in blends of high octane aviation gasoline, in refining processes, and in paraffin extraction. The TNT industry, in 1958, absorbed 1.5 million kg.

The ortho isomer of xylene is the one most used in the petrochemical industry in the production of phthalic anhydride. This product, important in the manufacture of synthetic resins and paints, is consumed by private industry to the extent of 2 million kg/yr., and since 65% of the anhydride is xylene, a yearly demand of 1.3 million kg is expected.

Considering these facts and allowing for the possibility of exporting benzene, plus the 12% increase in domestic demand per year, the future of these Pemex installations in Minatitlan is assured.

The production figures when the new Pemex aromatics plants go on stream in 1961 are estimated to be:

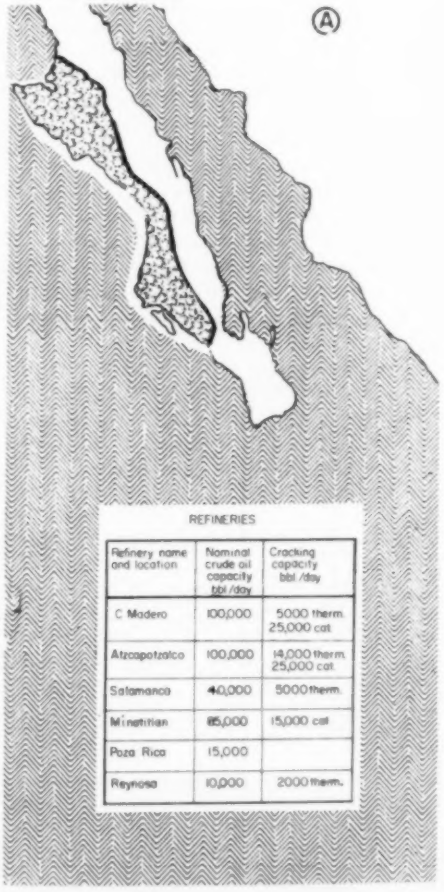
Benzene – 42,300 gal./day–367,-300 bbl./yr.

Toluene – 82,000 gal./day – 711,-635 bbl./yr.

Xylenes – 61,300 gal./day – 532,-580 bbl./yr.

From these figures it may be concluded that:

1. The amounts of each of the aromatics produced in Minatitlan, starting 1961, will be consumed entirely by the domestic market.
2. Petroleos Mexicanos will be the largest consumer of Mexican manufactured aromatics.
3. Production of aromatics on a vast scale is imperative.



REFINERIES

Refinery name and location	Nominal crude oil capacity bbl./day	Cracking capacity bbl./day
C. Madero	100,000	5000 therm. 25,000 cat.
Atzcapotzalco	100,000	14,000 therm. 25,000 cat.
Salamanca	40,000	5000 therm.
Minatitlan	85,000	15,000 cat.
Poza Rica	15,000	
Reynosa	10,000	2000 therm.

4. The production of aromatics will yield an estimated total yearly savings of approximately $80 million.

Summary

Mexican petrochemical installations will be located in four principal geographic zones, in each of which construction is already under way. In summary:

Ethylene. The four petrochemical centers will manufacture a minimum of 23,000 ton/yr., Table 2, with potential increase by catalytic dehydrogenation of the ethane contained in refinery or natural gases.

Propylene. The same centers will produce about 70,000 ton/yr. of propylene. It will be used in the manufacture of tetramer and cumene. Propylene is used as a plastic resin; tetramer, alkylated with benzene, is a detergent industry intermediate; and cumene will be used to obtain phenol and acetone. Atzcapotzalco will produce 20,000 ton/yr. dodecilbenzene to cover the national demand of this product for detergents.

Table 2.

Location	Ethylene prod., ton/yr.
Atzcapotzalco	7500
Ciudad Madero	7500
Salamanca	5000
Minatitlan	3000
Totals	23,000

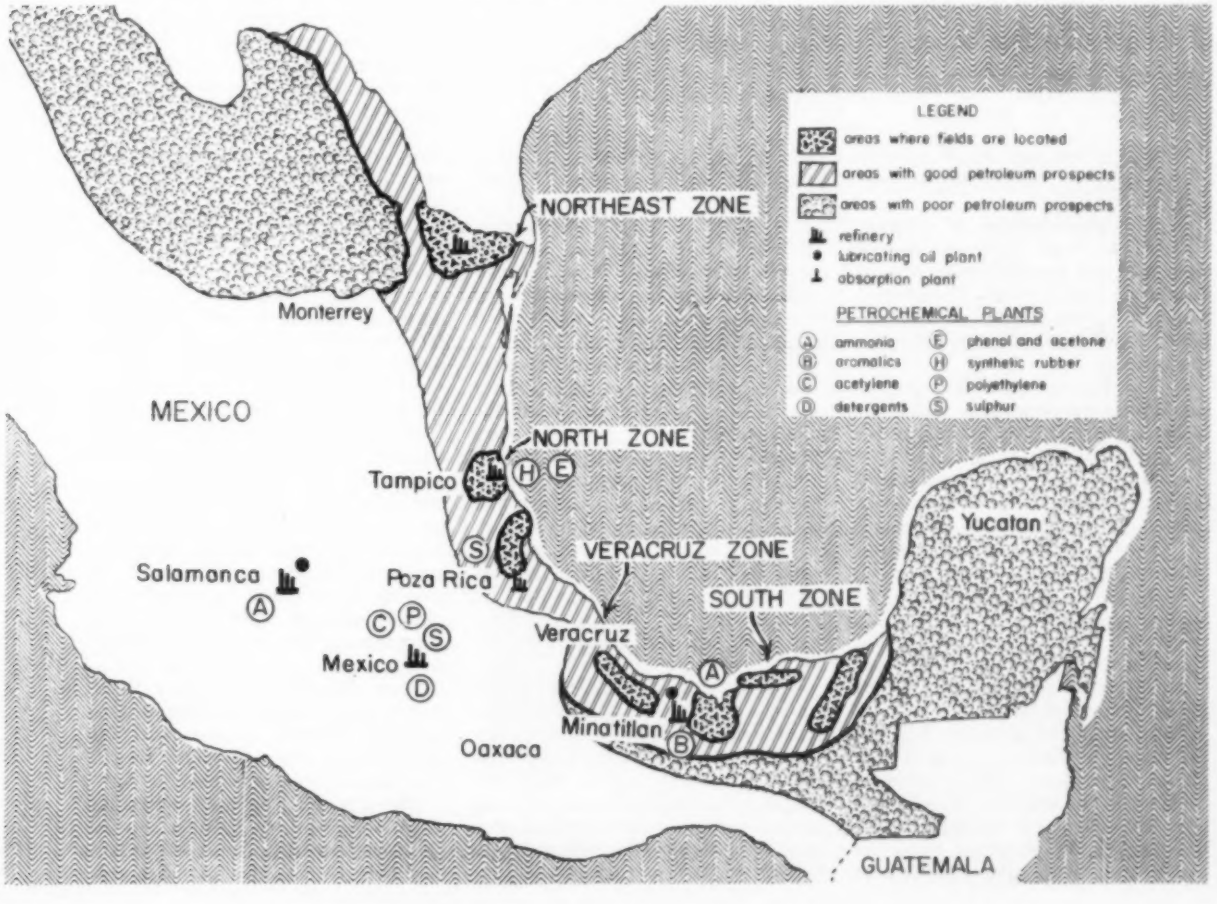
Benzene, toluene, and xylenes. These aromatics will be manufactured exclusively in Minatitlan, in the quantities described earlier. Private industry will be responsible for the production of the derivatives from them, such as: DDT, chlorinated derivatives, phthalic anhydride, etc.

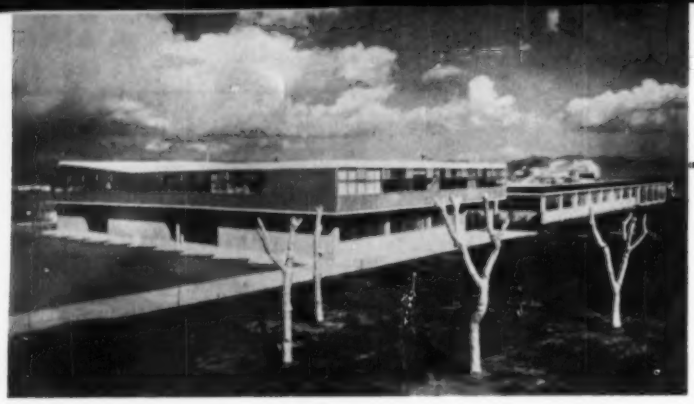
Ammonia. This is one of the most important products in the Mexican national petrochemical program. Three plants are under construction, each with a 200 ton/day capacity. These plants are located in Salamanca, Minatitlan, and in northern Mexico. They will use natural gas as a raw material. As a result, other related chemical plants will also be erected near them. It is quite probable that future demands by Mexican agriculture will require increased production.

Acetylene. The plant to manufacture this product will probably be located at some point along the gas lines. This project is expected to be started at a later date than the others.

Table 1.

Product	Mexico imported, kg	Mexico produced, kg	Benzene in product, %	Benzene req'd., kg
Nylon	5,500,000	—	30	1,650,000
Dodecilbenzene	16,000,000	—	35	5,600,000
Chlorobenzene	1,225,000	175,000	70	1,120,000
Mono- & polystyrene	2,715,000	6,000,000	74	6,300,000
DDT	75,000	6,000,000	65	3,950,000
Synthetic rubber	24,000,000	—	55	13,200,000





Pfizer's pharmaceutical plant, Toluca, Mex.

CHARLES E. WARING
W. R. Grace & Co.

Chemical industries U.S. and Latin America —the differences

You need to know the local conditions in each Latin American country before you can make construction cost comparisons.

IN TRACING THE HISTORY of a developing economy, four stages can usually be identified:

A. The pre-industrial or commercial stage in which trade may be well developed but manufacturing is rudimentary or non-existent. However, a monetary system, means of transportation, agriculture, and commerce are in existence.

B. The primary manufacturing or export of resources stage in which the processing of materials for export usually predominates.

C. Manufacture of non-durable and semi-durable goods in which the first industrial operations begin to emerge. The chemical industry has its origin in producing the chemicals required.

D. Durable and capital goods manufacture characterized by the development of heavy industry. It requires basic metal industries. All types of capital goods and machinery are manufactured locally.

Latin American countries fall into two major classifications as far as their phase of economic development is concerned. The so-called "large" countries have advanced through the first three stages. In economic terms we can define these large countries as those whose gross national product is from 3% to 5% that of the U.S. Three Latin American countries qualify as large: Argentina, Brazil, and Mexico. All other Latin American countries can be classified as "small": Venezuela's gross national product is about 1%; Chile, 0.5%; Peru, 0.33%; and Ecuador only 0.05% of the U.S. GNP. In considering Latin American chemical industries, we must make a clear distinction between those in the large countries and those in the small countries.

In Argentina, Brazil, and Mexico the size of the market is such that United States and European chemical technology is adaptable without difficulty. In this respect European technology is more readily adaptable than U.S. technology because European countries such as Switzerland, the Netherlands, and Austria have developed small plant designs to supply markets roughly of the same size as those of Argentina, Brazil, and Mexico. In the small countries the markets for chemical products are so small that the plant size required to supply their markets is often roughly equivalent to that of a large pilot plant in the United States. For example, in the U.S. a small ammonia plant is of the order of 150 ton/day capacity; in some of the Latin American countries ammonia plants having capacities as small as 20 ton/day have been designed and erected. In the U.S. a plant to produce chlorine and caustic would usually be of the order of 250 ton/day of each product. In small Latin American countries plants may be as small as 5 ton/day capacity and in countries like Ecuador the capacity required to supply the market might be even less. However, it is simply not possible to design these plants as one would design a U.S. pilot plant because of the difference in the "economic equation". In the U.S. the economic equation involves high labor costs and low capital costs, in Latin American countries the reverse is true.

Some simple arithmetic based on what a company can afford to spend to eliminate one operator position in a chemical plant illustrates the situation. Under U.S. conditions a skilled chemical operator may cost $6000/yr., including the usual benefits. A continuous process requires four men at every station to maintain round-the-clock operation, or $24,000 per station. Assuming this position is eliminated by mechanization, and the money for such mechanization is raised on the basis of debt capital at 5%, and the fixed charges including depreciation, maintenance, and insurance add 15%, then a total of $120,000 in capital can be spent to eliminate one operator position.

In some South American countries the labor rate is roughly $2.00/day, $600/worker/yr., or $2400/yr. on the basis of four men to a position. Debt capital is about 10% and if borrowings are difficult to arrange, the case in many countries, equity capital must be provided. With equity capital at, perhaps, 15% after taxes, the average cost of capital on a before-tax basis may be as high as 20%. Adding this amount to 15% fixed charges gives 35% as the cost of an investment in machinery. Therefore, only about $7000 would be allowable to eliminate one operator position as compared to $120,000 in the U.S. This doesn't buy much mechanization.

There is also a political implication in this problem, because in most of these countries it is considered socially desirable to provide maximum em-

ployment. The population growth rate throughout these countries is about 3%/yr. In the United States there is a great deal of debate about desirable growth rate for our economy. Some of our most advanced thinkers maintain that we should have an economic growth rate of 5%/yr. If 3% is pretty good (and this is what the U.S. growth rate has been over the last several decades), and we translate this to the Latin American countries, such a growth rate is really only keeping up with the population growth, with little gain on a per capita basis.

There is also a very great difference between the small countries and the large countries in the availability of locally manufactured equipment. In Argentina, Brazil, and Mexico chemical plants can be built without great dependence on imported process equipment. It would be necessary to import only very highly specialized equipment. In the small countries it is necessary to import practically all equipment for the chemical process industries as there are few local metal fabricating shops available even for producing relatively simple tanks and similar equipment. Countries such as Uruguay, Paraguay, and Ecuador do not have basic steel industries and hence must depend on imports for even the simplest process equipment. Chile, for example, is intermediate in its stage of development. It has a basic steel industry and metal fabricators can produce simple vessels capable of operating under moderate pressures, but the metal fabricating industry is not yet sufficiently advanced to produce complex machinery or high pressure vessels.

There are many other local conditions which have to be considered when adapting chemical industries to the various Latin American countries. A case which illustrates the situation well is that involving the production of chlorine and caustic. These are so-called co-products which are produced in a constant ratio of approximately 0.9:1. As countries progress from the commercial stage into stage B, the primary manufacturing stage, the need for caustic soda appears. However, at this stage there is very little need for chlorine, as chlorine is usually used in making products which are required only in stage C or stage D. Consequently, the chemical manufacturer who undertakes the production of chlorine and caustic usually finds that he has almost no market for the chlorine and must develop some uses for chlorine or else find that the chlorine must be disposed of as a waste product at considerable cost. As an example of this, Peru is in the stage where there is a high demand for caustic, but little demand for chlorine, the demand for chlorine being only 20% of that for caustic. Brazil is much further advanced industrially than Peru and yet chlorine is still in excess supply in Brazil. However, the increasing use of plastics, such as PVC, containing chlorine is creating a market for the chlorine in Brazil, and as Brazil advances further in stage D, it can be predicted that the demand for chlorine will approach that of caustic.

Another interesting situation in Latin American countries is that relating to steel production. As countries emerge into stage D, one of the first industrial developments is the manufacture of steel. This usually requires the manufacture of coke and thereby produces the usual coal chemical byproducts. These byproducts, together with the availability of chlorine at low prices often give rise to a chemical industry based on solvents, insecticides, and other chlorinated products.

Nearly all Latin American countries have an exchange problem. They require large amounts of foreign exchange to import capital goods for their developing industries. Often their exports consist largely of minerals or agricultural commodities subject to wide price fluctuations and consequently they often have trade deficits. Therefore, it has been necessary for most of these countries to institute exchange controls of some sort. This has usually led to requirements for import licenses wherever foreign exchange is required. In undertaking a new chemical development in Latin America it is often necessary to justify the need for such an import license by demonstrating that the new chemical venture will produce materials locally which will eliminate the need for imports, and that consequently a net saving of foreign exchange requirements will result from the construction of the plant. In some countries, even in spite of the proven desirability of a new plant from the standpoint of reducing exchange requirements, the local laws make it very difficult to obtain the import license. For example, in several countries it is often necessary to post a cash bond in local currency covering the entire cost of the equipment to be imported under the import license. In the case of a specialized piece of equipment for a chemical plant the delivery time from the date of obtaining the import permit may be from one to two years. If, for example, a machine costing $100,000 is built especially to order on a one-year delivery schedule, and requires a 100% deposit, the posting of a $100,000 bond under the import license may add as much as $10,000 to the cost, since interest rates in Colombia may run as high as 10%. This is typical of extra costs encountered under some Latin American conditions which are unknown in the U.S. and which might be neglected by an engineer not familiar with the local conditions.

The difficulty and expense involved in importing equipment into these countries make it desirable to use local resources to the utmost. It may be desirable to use a simplified equipment design which can be manufactured locally rather than resort to imported equipment, even though it is necessary to make some sacrifice in the efficiency or durability of the equipment. For example, under certain conditions it may be desirable to use wood tankage rather than steel tankage.

In conclusion, there is no way of making direct comparison of plant construction costs in any Latin American country with those in the United States. Plants must be designed to operate according to local conditions involving not only engineering consideration, but also political, sociological, and materials-availability conditions. Only a thorough knowledge of the situation existing in each country will permit a final design best suited for the local situation. #

Charles E. Waring, a vice president of W. R. Grace, was named to his present post in 1956. Waring began his career with Eastman Kodak, in 1927 as research chemist. He was also with the Frigidaire Division, General Motors, for fifteen years. He joined Davison Chemical in 1945, and the next year became vice president, research and development. Since 1952, his work has been general business development here and abroad. Waring has an MS and Ph.D from Ohio State.

G. R. Lawrence
The Lummus Co.

Construction costs in Latin America

In Latin America, as elsewhere, the economics of production of many materials are a continuing object of study. A basic element is the investment cost of the plants involved.

How are U.S. plant investment costs translated to their equivalents in various Latin American locations? The effects of the main variables which influence the answer to this question will be examined and we shall see that, unless too many adverse conditions are combined for a given case, the cost of a Latin American plant is reasonably predictable and not appreciably different from its U.S. counterpart.

Plant cost factors

Detailed study of the variables discussed below will give a fair approximation of their effect on the cost of materials, construction, engineering, and contracting services which, for purpose of definition, add up to the installed cost of a plant.

Accessibility of location. Freight cost is the most obvious direct effect of geographic location. This factor may add over 10% to the cost of materials at the southern end of our hemisphere whether they originate in Europe or the U.S. In most cases, too, geographic location means isolation from equipment manufacturers, technical assistance, and specialized maintenance. Consequently, the basic design of the plant is affected. Equipment must be so designed as to insure planned production with a minimum of shutdowns. This means, in turn, an over-all plant cost increase in the order of 5-10%.

Furthermore, because of isolation, a stock of spare parts sufficient for one year's operation should be maintained. This adds, roughly, another 2-3% to the over-all plant cost. Isolation may also necessitate addition of plant repair and maintenance shops, particularly if the plant must run at a high operating factor.

Also, because of isolation, raw materials and/or products storage and distribution facilities may need to be more ample.

Lastly, and important although not by definition a part of the installed cost of the plant, is the sometimes essential need for early personnel training. A new industry, depending (of course) on its complexity, may need to hire, school, and train its managerial, operating, and maintenance forces at lengthy intervals before actual start-up. The costs for these are justified when evaluated against the alternate possibility of weeks or months of reduced or irregular performance due to poor operation.

Climate. In general, climate is not an influential factor on the cost of a plant originally estimated in the U.S. A tropical location will usually require a less elaborate installation than one originally designed for severe winter conditions and incorporating devices against freezing, more substantial equipment enclosures and buildings, and deeper foundations. But again, we may run into special cases where additional costs must be considered. Large plants in tropical coastal regions, for instance, have a cooling water problem if sea water is to be used.

Construction labor and tools. The published hourly cost of labor in most Latin American countries is strikingly lower than that prevalent in the United States. Even after corrective adjustments for relative productivity, social benefits, special conditions, and additional cost of foreign supervision, we arrive at construction costs which can be 75% or less than their U.S. counterparts. But there is no uniformity. In Venezuela, for instance, construction work in the oil industry can actually exceed its U.S. equivalent.

In large projects, the unavailability of heavy construction tools in certain countries can be very costly if such tools must either be acquired for a single project, or rented, with inevitable idle time while tools are in transit.

Origin of materials. Depending on the country involved, the point of origin of materials may have the greatest influence on the cost of the plant. The effects of applicable duties, or of legislation stipulating local purchases, even when non-competitive pricing and deliveries do result, are obvious.

For processes operating at moderate pressures and not requiring special metallurgy, national industries have developed in Latin America to the point where substantial plants, involving over a million-dollars worth of materials, can be provided locally to about 80% of their value. This percentage includes components made locally of imported materials.

However, even in the more industrialized countries, the national industries are not tooled, nor can they be tooled economically to the tempo of accelerated construction programs now under way. And even in those countries where they could theoretically be manufactured, a large percentage of the materials must be imported if a reasonable construction schedule is to be maintained. At present, local materials seldom exceed 20-40% in the more industrialized countries.

The question continually arises whether to import materials from the U. S., from Europe and, more recently, from Japan. This is subject to individual evaluation. Freight rates, characteristics of equipment, and delivery periods must be compared. If the materials are taken as a group, there is no appreciable difference today. Actually, financing almost invariably governs the point of origin of foreign materials.

Financing. Most Latin American CPI projects benefit from foreign long term financing. Aside from governmental terms extended for selected projects by such agencies as the Export-Import Bank, for some time manufacturers of materials, particularly in Europe, have made terms available involving some 15% cash before delivery and the 85% balance payable during five years or more after delivery.

Compania Shell de Venezuela at Cardon, Venezuela has 300,000 bbl/day capacity.

There are many financing plans or combinations of plans available, particularly for large projects. Materials can be obtained from a single country either on a competitive basis within that country, or as a package, to reduce the enormous amount of paper work involved. If the project is large enough, it may be profitable to shop selectively in different countries.

Interest rates range between 6-7%, to which are sometimes added special financing charges. Often, engineering and contracting services are financed as a package with the materials. Under prevailing conditions, financing costs add (on the average) 15-20% to the value of the materials and services covered.

Reliability of utilities. Estimates of process plants usually cover the process facilities proper. Utilities must be provided, either from existing sources, or from new facilities. The main variable is electrical power. An uninterrupted, steady electrical source is indispensable to efficient operations, particularly for larger plants. In many locations, this may require the substantial additional cost of installating generating facilities.

Size. As a fair rule, the cost of plants of different sizes is proportioned to the ratio of their sizes factored to the six-tenths power . . . . except when the plants become very big, or very small compared to what is considered the median standard.

Where factors make the manufacture of any chemical attractive at a given location, the market may still be too small to support what may be considered a small plant by U. S. standards. This results in the design of plants which are economically justified in certain countries, but for which the ratio of investment cost to quantity of product may be out of line with that prevalent in the U. S.

While it may be academic, it must be stated that there is such a thing as a minimum-size continuous operation plant. There is indeed a point where a reduction in size of the equipment is hardly accompanied by a correspondingly favorable reduction in installed or operating cost. The evalution of this minimum size is admittedly difficult, however, when costs must be prorated from considerably larger U. S. plants. While the costs of material, and labor can be approximately downgraded, the cost of engineering and contracting services will hardly diminish, and thus becomes larger in proportion to the total cost of the plant.

Example. Assume that a Latin American plant whose total U. S. installed cost is $2 million is located in an industrial community where machine shops and maintenance facilities are available and that there is no need for private electric generating facilities. Assume also that financing costs are equal. What will be the cost of the Latin American plant?

Materials costs represent about 55-60% of the cost of the U. S. plant. If local material costs are equal to U. S. costs, but if 70% of materials are of foreign origin and if we must add 10% on these for freight, then we have an addition of about 4% on the over-all cost of the plant. To this add 3% for spare parts, and 5% for extra sparing and special design features. Our total excess is 12%.

G. R. Lawrence is a sales engineer with the Lummus Co. Currently, his activities are predominantly in Latin America. In the eight years since he joined the company, he has worked as coordinating engineer, project engineer and project manager for the design and construction of petroleum refining, petrochemical, and other chemical facilities.

The costs of labor, labor supervision and tools amounts to some 25% of the cost of the U. S. plant. This latter figure further breaks down in the U. S. into about 2/3 for actual equipment erection, and about 1/3 for supervision and tools rental. The cost of supervision and tools rental will actually increase because of extended construction periods and higher rates. However, for the moment, let us assume for the sake of arithmetic simplicity that the entire 25% under discussion will vary proportionately with local wage rates. Now, suppose we find that the local labor hourly average rate is one sixth of that prevalent in the U. S. On the other hand, the productivity is evaluated at 50% of U. S.; social benefits, holidays, compulsory severance pay, etc. impose an 80% surcharge on actual salaries. All this means, arithmetically, that the cost of labor is 60% of its U. S. counterpart. Assume now that, taking into account the extra costs of foreign supervision together with contingent items such as living and travel costs of personnel involved as well as higher tool rentals costs, we conclude that the cost of labor is 70% of that performed in the U. S. Our total saving is about 7%.

The cost of engineering and contracting services amounts to some 15% of the cost of a U. S. plant of this size. These costs vary little with location.

So, in our illustrative case, we have a plus of 12% due to origin of materials and location, and a minus of 7% for construction labor. The net result is an increase of 5%. What we have just tried to illustrate is that, under average conditions, the installed cost of Latin American plants does not vary by more than 10% from their U. S. counterparts.

The near future will probably see plant costs in the more industrialized areas of the entire Western Hemisphere converge more closely. A larger proportion of materials will be obtainable regionally, particularly because of Common Market arrangements. Latin American labor wage rates will tend to rise rapidly, but the effect on construction costs will probably be compensated through increased productivity.

JOSEPH J. FLANAGAN
Monsanto Chemical Co.

Manufacturing costs in Latin America

It's difficult to transpose U.S. cost estimates into their Latin American counterparts without some knowledge of the characteristics of the country and its people.

TO AMERICAN COMPANIES who have successfully developed the technologies of profitable manufacturing processes, it makes good sense to apply them abroad as well as at home. Latin America is a prime field for such activity.

When a U.S. engineer is asked to develop a Return on Investment estimate for a project in, say, Argentina, perhaps the case is made simpler for him by defining what size plant is needed, or perhaps not. This is often the question requiring the most soul-searching. As often as not, it is resolved by an "intuitive" guess. To attempt to estimate a market potential, using domestic production, by extrapolation of *what it has been* with 100% importation and high tariffs, is akin to the question about the hen and the egg. This is an interesting area but irrelevant to the immediate subject; ultimately, the engineer must define a project scope and arrive at capital and operating cost estimates.

He may be an excellent estimator of new projects in his own plant, and for jobs anywhere in the United States, but how can he estimate for a job in Argentina when, perhaps, he knows only that things are different there? Obviously he cannot, without becoming better informed. Yet, at least for preliminary estimates, he may feel more ignorant than he actually is.

Developing a manufacturing cost estimate for a Latin American project does not differ in basic procedure from any other. Any differences are simply in price and efficiency factors, and in the difficulties in obtaining accurate data when preparing final versions. The determination of yields, cycles, utilities requirements, labor and supervisory staffing, and so forth is fundamental to operating cost estimation. It is assumed that these factors are well known for the process as developed and practiced in the United States; they must now be translated to the Argentine plant.

While U.S./Argentine cost ratios can be established and used in estimating the various elements of a capital estimate, the same cannot be done for operating costs, except for such specific factors as to make them of little value. For a detailed estimate one must go back to the basic elements involved. In estimating steam cost, for example, it is necessary to know delivered fuel cost, heating value, boiler thermal efficiency, labor hours and rates, and so forth. Obviously, steam cost per 1000 lb., or per unit of product, will vary with the size of boiler.

How can the estimator accumulate all of the pricing information he needs to know to develop his estimate? It is our experience that by the time a project evaluation reaches the point of detailed estimates, there is an interested and informed individual in the country concerned ready to feed required information. This person may be the company's local sales representative, a customer wanting an assured local supply of raw material, or someone in the Overseas Division or International subsidiary whose job is to find promising foreign locations where the company may manufacture its product or products profitably. Should no locations be evident, the country's consulate at Washington would be happy to provide local information in most instances. This information, however, is usually too general for use in a defined estimate. Before a project is committed the estimator must have accurate, detailed, and specific information, and lacking a reliable local

Going on stream in Bahia, Brazil, this Petrobras refinery was engineered by M. W. Kellogg with a local Brazilian contractor.

source, should go there himself to obtain it.

The traps the American engineer can fall into are legion; mainly because he does not fully appreciate the primitive environment with which his potential plant will contend. He must be able to weigh the impact of the low level of industrialization and prosperity of the country on his project. He must realize that the suppliers are not minutes away by telephone with plenty of materials; that the workers have no telephones, and walk, ride bicycles, or take a bus to work.

Raw materials

Projects in Latin America are not necessarily justified because of their ability to produce for the local market cheaper than the same product could be imported. Many are fostered by the existence of import tariffs or by the assurance that such will be applied when the domestic product is made available.

What applies to the potential plant's product applies just as well to its raw materials. Are they made domestically? Are they made in sufficient quantity to satisfy the plant's needs? What quality are they? Are there alternative suppliers? These are very real and basic considerations. The mere fact that a local company has satisfactorily shown itself capable of manufacturing a given chemical may be sufficient to result in a several-hundred-percent tariff being placed on its importation.

Dibutylphthalate and dioctylphthalate plasticizers, for example, are made by similar processes. A local company may make one, perhaps, for its own captive use. By its demonstrated operation it could obtain tariff protection not only for the one, but for both—and conceivably, for a whole family of related esters! One cannot naively assume that raw materials will cost the "going" world price, plus freight. Indeed, the cost, supply, and quality of raw materials are likely to be the most important factors to be resolved, while at the same time being the most difficult of resolution.

Utilities

Costs of utilities are relatively easy to estimate compared to raw materials in the sense that the plant must usually supply its own. The Latin American plant would conceivably be equipped with its own wells, or treating facilities for a nearby surface water source. It would have its own steam plant, more than likely, oil-fired. To the extent that utilities, notably electricity, would be furnished by others it is important to determine the degree of reliability to be expected, and that there is an adequate supply. Many areas of Latin America are deficient in electrical power, and it is a rare area where a grid system (where several sources are tied together to assure better dependability and distribution) may be found. Many places depend upon small hydroelectric plants, where the

Table 2. Some comparative costs.

PRODUCT A (Principal raw materials imported by Latin countries)

	Manufacturing Costs		
	U.S.A.	Mexico	Argentina
Raw Materials	80	145	265
Utilities	2	6	6
Salaries & Wages	7	2	5
Maint. & Supplies	3	3	7
Other Directs	2	2	3
Total Directs	14	13	21
Depreciation	2	3	7
Other Indirects	4	3	3
Total Indirects	6	6	10
Total Mfg. Cost	100	164	296

PRODUCT B (Principal raw materials produced in U.S.A. and Argentina, not Mexico)

	Manufacturing Costs		
	U.S.A.	Mexico	Argentina
Raw Materials	78	108	162
Utilities	4	20	17
Salaries & Wages	5	4	2
Maint. & Supplies	3	5	8
Other Directs	4	3	6
Direct Conversion	16	32	33
Depreciation	3	7	6
Other Indirects	3	5	3
Indirect Conversion	6	12	9
Total Mfg. Cost	100	152	204

supply varies seasonally for lack of reservoir capacity. In such instances, especially if all utilities are dependent on electricity, the safety of the operation, as well as operating efficiency, may be at stake. The efficiency of many continuous processes (both in terms of operation and product quality) is often more a function of freedom from interruptions – however brief–than it is of cumulative outage time. Emergency standby power may be needed to keep critical units in operation, and must be "costed" in labor, fuel, and depreciation.

Labor and supervision

Of all prospective expense items, those covering labor and supervision have the greatest potential for lowering manufacturing cost. This is illustrated in Table 1 by a comparison of hourly basic wage rates of several countries.

Table 1.

	U.S. $	% of U.S. Rate
Argentina	$0.49	21
Colombia	0.21	9
Mexico	0.25	11
Peru	0.29	12
Venezuela	0.77	33
United States	2.35	..

These rates do not include fringe benefits or social charges, which add 44% to production workers' cost in Argentina, approximately 20% in Mexico, and approximately 12% in the United States.

Here again one must not factor glibly, for labor efficiency must be considered. Depending on the situation, this may equal the U.S. standard, effecting considerable relative savings, or be so much lower that gross labor cost approaches the U.S. figure.

There are a number of reasons which must be recognized for such cost variation. Most significant, perhaps, is that cheap labor and size of installation will often work together to void justification of labor-saving devices which would normally be included in the typical U.S. plant. This can be especially true in so-called "Spartan" plants, where the smallness and uncertainty of initial market demands dictate rock-bottom capital expenditures. Low educational level and lack of prior industrial experience on the part of the workers available at a new site result in lower efficiency hard to measure quantitatively. On one Argentine construction job absenteeism averages 15% – unskilled workers being the main offenders.

Maintenance and supplies

In addition to the Latin Government's desire to conserve foreign exchange, there is a problem in stocking spare parts which rules in favor of local equipment purchases wherever possible. Where a process requires alloy or special equipment there may be no recourse but to import–with the concurrent penalty of a heavy spare parts inventory. Short of having a complete spare plant on the shelf, there is no way to assure that one day some part, not spared, will break or wear out. The attendant delays in replacing such items from a factory several thousand miles away can cost as much, or more, than to have the same item fabricated locally, even though the latter course may seem outrageously prohibitive. In many instances, such a procedure is impossible, in which case the plant is shut down or crippled until a replacement can be flown in.

The earlier comment about lack of industrialization being a basic inflator of costs applies here also. Even though labor, a prime element in maintenance anywhere, is low in cost, efficiency can be proportionately low –because of the lack of tools, special skills, and other resources by which the American plant can quickly make repairs with minimum labor.

Anyone who has ever had the opportunity to witness contruction jobs in the U.S. and in typical Latin America will appreciate the extent of contrast to be found. For lack of cranes, heavy equipment is not set in minutes, but in hours, or even days, using gin poles, A-frames, hand winches, and pry bars. Hack saw blades are used by the hundred on a piping job. Foundations are dug and poured in the time honored fashion. If an instrument is broken–this a good test of the thoroughness of project organization and planning. The gist of these remarks is that the resources, skills and craftsmen required for economical plant maintenance must be self-generated to a far greater extent in the Latin American plant, and that such maintenance, even with low-cost labor, will cost as much, or more, than in its U.S. counterpart.

Joseph F. Flanagan is with Monsanto Chemical. As supervising engineer, responsible for technical liaison with the director of overseas manufacturing, he has in recent years spent some time in Spain and Argentina. Flanagan has been with Monsanto since 1942, except for two years in the Army Chemical Warfare Service. He has worked in various departments of the company, including Melamine, Formaline, Resinox, and Styrene Polymerization.

Inflation

While inflation is most relevant in discussions of financing and capital costs, it extends its evil influence into operating costs as well. The estimator is cautioned to become familiar with the political and economic situation in the country concerned, and to make some reasonable allowance for inflationaary trends. Argentina is an example. Only five years ago the Argentine peso was worth five U.S. cents. In 1957 it was worth 2½ cents, and in late 1959 was down to 1¼ cents. Inflation does not affect all costs evenly; items derived through importation will react immediately and in direct proportion, while local items–labor, local raw materials, and purchased utilities–will react more slowly and in varying proportions. Because inflation robs the worker, at least momentarily, of real earning power, it tends to be accompanied by strikes which disrupt production and sales.

Summary

Throughout this article there has been a notable absence of quantitative information. This is probably contrary to the expectations of many. Readers who have experience in the area of foreign cost estimation will appreciate the prevalence of the idea that "factors" ought to exist, for easy translation of U.S. costs to other countries. Engineers like to use simple factors, particularly where they substitute for a complicated mathematical formula and even more so where they wrap up into a neat, finite number many qualitative, changing, opinionative, and difficult-to-find elements which must be expressed quantitatively in some way. The U.S. engineer would not look for a factor to transpose a Houston, Texas, cost to a Long Beach, California, one, but would try to do so if he wanted to express it in terms of Lima, Peru.

If there is any conclusion we would most like to emphasize, it is that there are no simple factors by which an estimator can validly convert one location's manufacturing costs to another location. If he is to develop an accurate number he must obtain basic cost and specific data for the site in consideration, and have a deep perception of the nature of the people and the country involved. #

S. H. McAllister
Agricultural Chemicals Div., Shell Chemical Co.

Pesticides—deadly competition

Formulators face rapid product turnovers, an exacting technology, and keen rivalry in the dynamic pesticide industry.

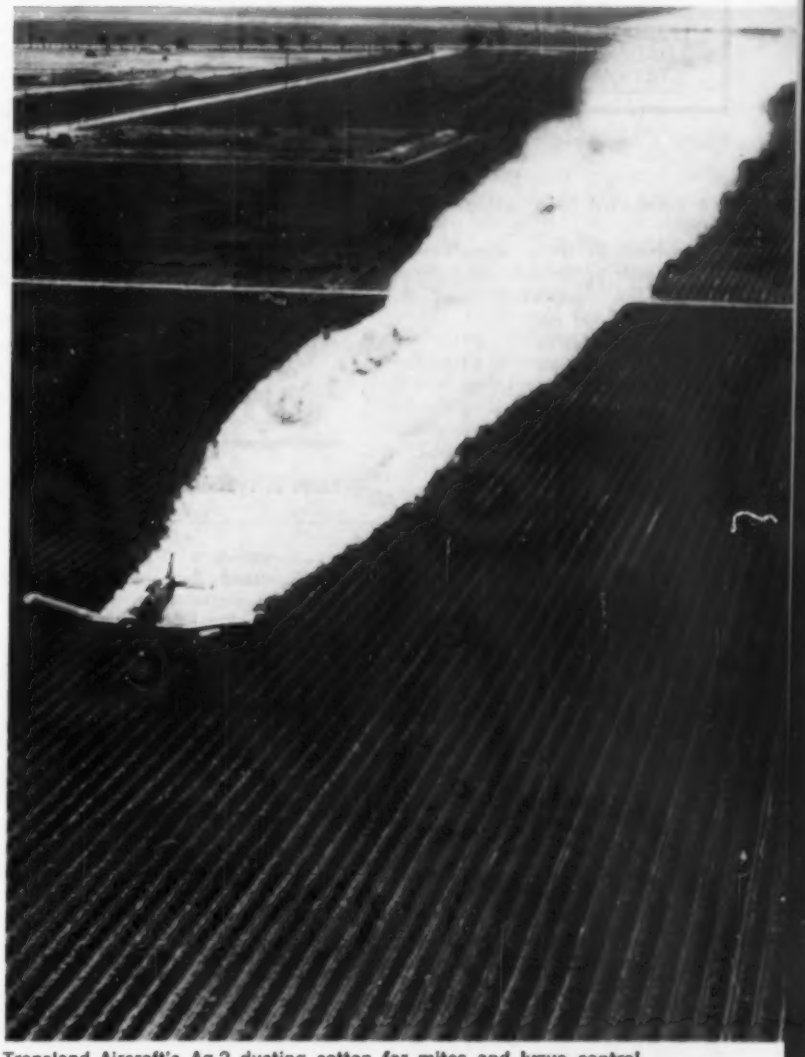
The economic problems and those problems involved in the development of new toxicants, difficult and costly as they are, represent only part of the over-all problem of introducing a new pesticide to the market. Almost all pesticides must be formulated for the end use and this involves a number of additional steps and expense.

Twenty years ago most of the products sold were relatively inefficient and were applied at high rates. For example, sulfur used as a fungicide for grapes was applied at over 20 lb./acre and calcium arsenate for cotton insect control at 10 lb./acre. Today some of our most effective chemicals have dosage rates of 1 to 2 oz./acre, or less than 2 mg. of toxicant per sq. ft. Obviously, good distribution and effective coverage are essential, thus placing a major responsibility on the art of formulation.

While nearly all pesticides must be formulated, this is not necessarily done by the manufacturer of the technical material. In fact, the industry may be roughly divided into three general groups as follows:

1. Producers and sellers of basic toxicants only—about 8 companies.
2. Integrated companies which manufacture toxicants and formulate finished products—about 16 companies.
3. Independent formulators—80-90 companies.

These classifications are neither rigid nor static. The industry is a dynamic one and major policy shifts can and do occur with the introduction of new products. This may be stimulating from the competitive standpoint, but it is confusing and is



Transland Aircraft's Ag-2 dusting cotton for mites and lygus control.

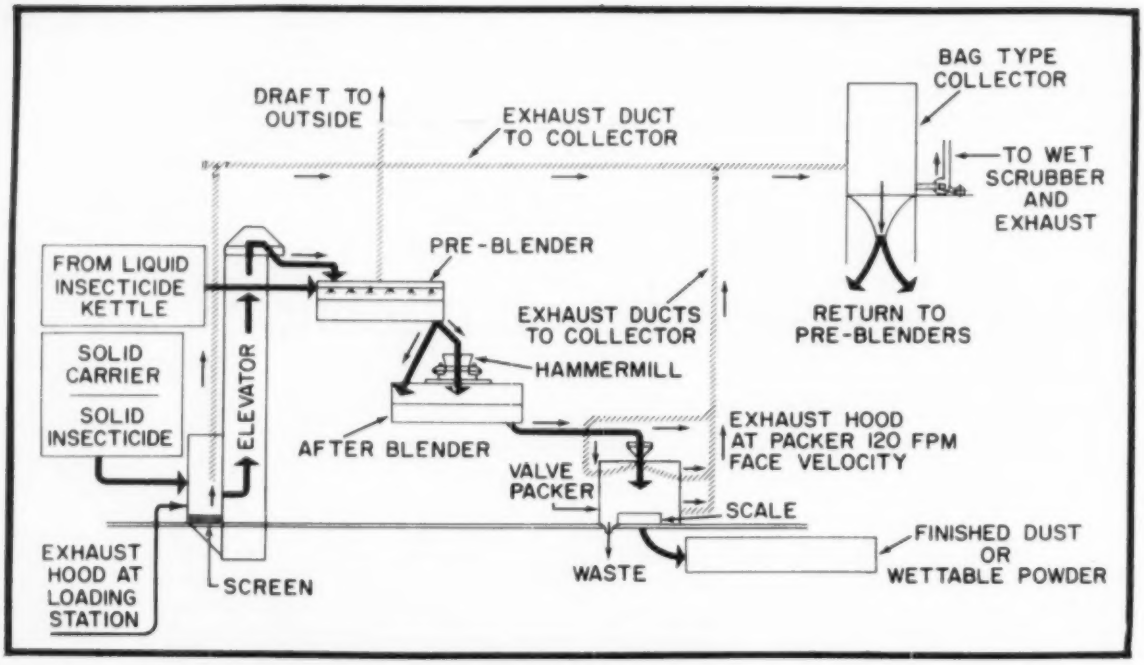


Figure 1. A versatile plant layout for the processing of solids in the formulation of pesticides.

not conducive to a stable dividend rate.

Involved in these operations are approximately the following number of chemical compounds classified as to pesticide end use:

Fungicides	67
Herbicides	84
Insecticides	66
Soil Fumigants	8
Rodenticides	11
	236

These 236 basic toxicants reach the consumer in one or more of about 7000 branded formulations.

One reason for the confusion is that a relatively large amount of capital is not required to enter the formulating end of the business on a local or regional basis. Many are attracted to enter the formulation field by the mirage of high markups and profits relying on the basic manufacturer to furnish a competitive toxicant and the technical know-how. Contrary to what many who are not familiar with the problems of the industry think, markups in general are not high considering the risks involved and the long-term problem of dealing with a fluctuating market. Nowhere is this more clearly evident than where government competitive bidding is involved; for example, in the wettable powders used for World Health malarial applications the profit margin is often less than 2% before taxes.

Types of formulations

While almost an infinite variety of formulations are possible, those of interest fall mainly into the following categories:

1. Dusts which are widely used for aerial and ground applications of insecticides and fungicides. Roughly a half billion pounds of solid diluents are used annually in pesticide formulations, mostly for dusts.
2. Wettable powders which are predominantly used for World Health malaria programs and in a less finely ground form as fruit sprays and seed dressing.
3. Granules which are mainly used

Table 1. Typical formulas for insecticide dusts, wettable powders, and granules.

	Composition, wt. %		
Ingredients	Dust	Wettable Powder	Granule
25% Insecticide dust concentrate	20.0	–	–
Technical insecticide	–	75.0	–
20% Insecticide solution	–	–	25.0
Deactivator	5.0	–	5.0
Clay diluent	75.0	–	–
Adsorptive carrier	–	20.0	–
Granular carrier	–	–	70.0
Surfactants	–	5.0	–
	100.0	100.0	100.0

Table 2. Typical formulas for insecticide emulsible concentrates and aerosols.

	Composition, wt. %	
Ingredients	Emulsible Concentrate	Aerosol
Insecticide	25.0	2.0
Petroleum hydrocarbon solvent	70.0	10.0
Emulsifiers	5.0	–
Knock-down agent	–	2.0
Propellant 11	–	43.0
Propellant 12	–	43.0
	100.0	100.0

for soil applications.

4. Emulsible concentrates which are the most widely used type for agricultural applications. Roughly 30 million gallons of nonaqueous solvents are used annually in pesticide formulations.
5. Aerosols which are employed in household and industrial applications where convenience of application rather than cost is the primary consideration.

Typical compositions of each type are given in Tables 1 and 2.

Solid formulations

An examination of the chemical and physical problems encountered in preparing suitable formulations must take into account both the chemicals involved and the product end use.

A typical dust formulation contains about 98% inert ingredients over which the toxicant must be uniformly distributed. Often the dusts are made up as 20-50% concentrates for ease of storage and transport, and then diluted locally as needed. The dust concentrates are made by milling the toxicant with the carrier or, in the case of a liquid toxicant, by impregnation with a solution.

For carriers, high absorptivity and good flow characteristics are essential and this makes the term "inert" rather deceptive. Herein lies one of the formulator's major problems. It has been estimated that a pound of the average kaolin or pyrophyllite ground to below 200 mesh represents a surface area in excess of 15,000 sq. ft. which contains a number of active chemical sites. If these are not neutralized or otherwise rendered inert, they can markedly affect the stability of the formulated product. Ordinarily we consider chlorinated insecticides as rather stable, but in this highly attenuated form decomposition is accelerated. In fact, before this was fully appreciated, decomposition in some instances was so rapid as to initiate fires. Today, many dust formulations contain some form of stabilizer. The situation with the present phosphate insecticides is even more serious, and while thermal effects are not pronounced, hydrolysis can occur with loss of biological activity. Considerable research activity is now in progress on this problem, but at present emulsions rather than dusts are favored for the phosphate group.

The problems encountered with dust formulations are found in an even more aggravated form with the wettable powder. These are widely used in World Health programs where they are diluted in the field with water of various degrees of hardness. They are made up as 50-75% active concentrates and they must have excellent flow characteristics even after prolonged tropical storage. Highly absorptive clays or synthetic silicas are used for wettable powder formulations since the surface areas of such materials are phenomenal. For example, a pound of material such as Hi-Sil* has a surface area of over 14.5 acres. The selection of carriers requires the best efforts of the colloid chemist and engineer and, in at least one instance, well over $500,000 has been spent on research alone to find a good solution.

A type of solid formulation which has gained considerable popularity in recent years is the granular formulation. This consists of the pesticide sorbed on a sized granular carrier such as clay, vermiculite, or some type of botanical material. Granules are very convenient for broadcasting pesticides to soil or to still water. They are easily applied by either airplane or ground equipment, they do not drift as dusts or sprays do, and they do not hang up on foliage. The granules are formulated by liquid impregnation. If the pesticide itself is a liquid, it can be sprayed directly onto the granular carrier. If it is a solid, it is melted or applied as a solution to insure complete coverage. Care must be taken not to exceed the sorptive capacity of the carrier. The granules are prepared in blenders, similar to cement mixers.

* *Trademark of Columbia-Southern Chemical Corp.*

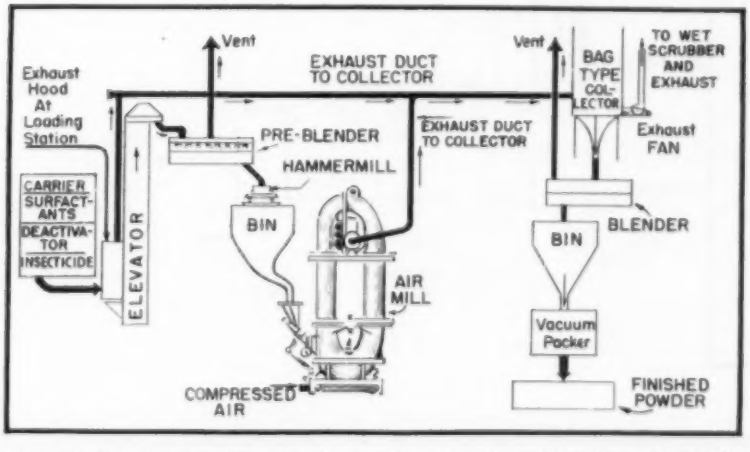


Figure 2. A typical flow diagram of a plant process for preparation of wettable powder formulations.

Emulsions and aerosols

The emulsifiable concentrate is by far the most popular. The research problems involved are mainly those of colloid chemistry and vary widely depending on the toxicant and application.

First, it is necessary to determine the solubility of the pesticide in a number of common solvents. The temperature at which these solubility tests are conducted is the lowest temperature at which the formulation will be stored, and may range from 32°F to as low as −10°F depending upon the location of the formulation. Inexpensive, relatively nonphytotoxic solvents such as mineral spirits or kerosene are preferred. However, where more powerful solvents are required, xylene or aromatic petroleum fractions are chosen, with great care being taken to see that they are not too phytotoxic. The next step is to select surface active agents which will provide the desired degree of emulsification. Emulsion requirements will vary widely, according to the different type of pesticide. An insecticide emulsion is most effective if it has good wetting and penetrating action, while a fungicide requires a quick-breaking, high-depositing emulsion. Herbicides, on the other hand, are sometimes formulated to give inverted emulsions; that is, the water is emulsified in the herbicide solution, rather than the reverse. The emulsifiable concentrates of agricultural insecticides are formulated so that they will emulsify spontaneously in water of varying hardness and stay dispersed for hours with very little agitation. They must not settle out or give rise to oil separation while the spray is being applied in the field as some types of spray equipment have large tanks with no agitation. The product should not show any loss of

toxicant or any decrease in emulsibility after two years storage at ambient temperatures, or after an accelerated storage test of equivalent severity.

In developing a formula for an aerosol pesticide, much will depend on whether the spray is intended as a wet, residual type, or as a true aerosol of air-borne particles. Mixtures of Propellants 11 and 12, CCl_3F and CCl_2F_2, are the most widely used for pesticides and comprise the bulk of the package, residual aerosols containing 25-50% of the mixture and space sprays up to 85% of the mixture. Some pesticides will require the use of an auxiliary solvent, which must be compatible with the propellant. The type of container and valve can also influence the performance of the product. Most aerosols are formulated and packaged for the household market, and are actually considered specialty items. Many formulators prefer to have their aerosols formulated and packaged for them by the specialty people. Actually the cost of the toxicant involved is a relatively minor item; the choice is made on the basis of the labeling requirements for the end use.

The above are only examples of the many problems and variants involved in the formulation of pesticides. From the economic standpoint, it should be readily apparent that major research expenditures are involved in developing suitable formulations for new pesticides. In addition, the manufacturer of the basic toxicant is required to do much of the service work needed to keep his customers economically competitive. Such service work can, for a major manufacturer of toxicants, amount to well over $500,000 a year, and is part of the hidden ingredient in every package. It also must be included in the cost of the pesticide if one is to remain in business.

Manufacture of formulations

The manufacture of pesticide formulations involves a number of processes, the most important of which are the dry mixing and grinding of solids, the dissolving of solids in liquids, liquid impregnation, blending, and packaging. A considerable amount of very practical engineering is involved in each of these steps.

Dry mixing, or blending, is the process most often used in formulating. Uniformity of product is always important, but it is particularly critical in dilute dusts which contain only a few percent of toxicant. The volume of product being handled is frequently large, and residence time in the blender must be kept to a minimum. Ribbon blenders of various designs are used for this application as they give the best mixtures of these bulky powders in the shortest time.

Grinding is an essential operation in the formulation of most pesticides. Many pesticides are solids, and these must be reduced to sub-sieve size when making them into dust concentrates or wettable powders. The toxicant is pre-mixed with the carrier and fed into the mill, which is usually a hammer mill if relatively coarse dust is required. A good formulator watches his throughput rates carefully; slow rates are, of course, inefficient, but a rate that is too fast will cause overheating in the mill and result in considerable down time for cleanout. In the preparation of high-suspendibility wettable powders for public health use, an extremely fine particle size is required. Such products are ground in a fluid energy mill, or air mill. Here the material is fed into a circular or oval chamber, where jets of high-pressure air cause it to circulate violently and to break into a very fine size because of the repeated particle collisions. This is one of the most effective milling methods known. Unfortunately, it is also an expensive method, because of the high energy requirements supplied in the form of compressed air. Because of the high operating costs, efficiency of operation and maximum throughput rates are essential.

The process of liquid impregnation is of particular interest. The liquid is sprayed onto a bed of carrier, which is kept tumbling in order to present a continuously fresh surface to the

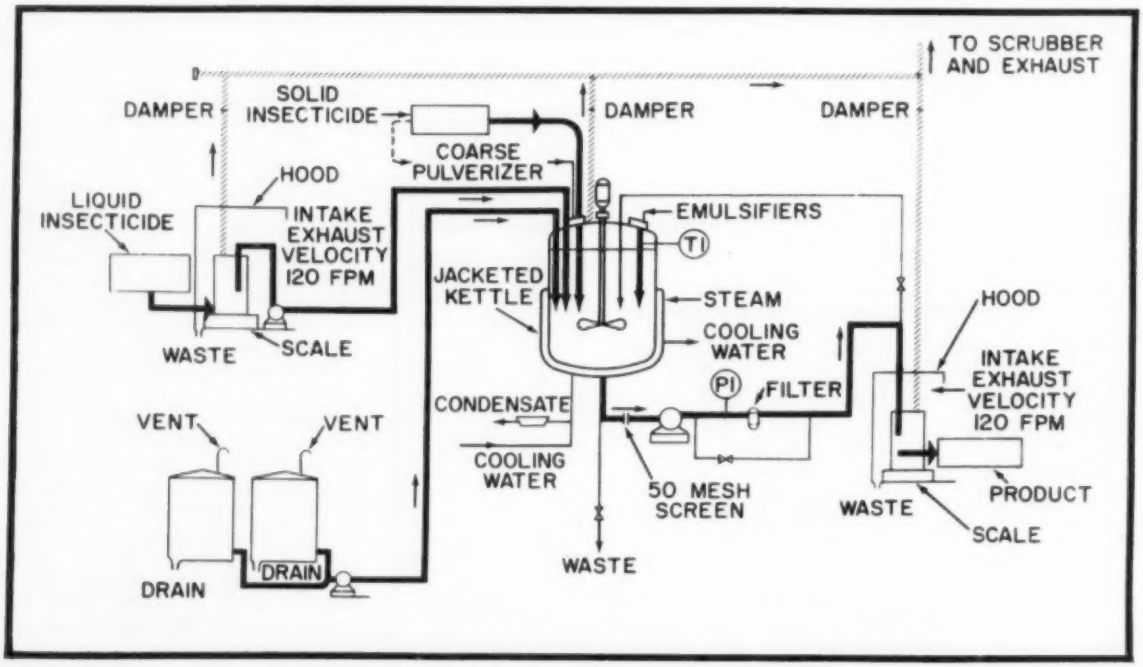


Figure 3. Flow diagram of a liquid formulation plant used in preparing emulsible concentrates.

spray. The formulator is faced with the problem of attempting to get some of the spray on each particle, and this may be impossible if the carrier is highly absorptive and the quantity of liquid is too small. However, if the formula has been properly worked out, the quantity of liquid will be adequate, and the formulator can get good coverage by spraying the liquid through nozzles having low delivery rates, while turning over the bed of carrier at a rapid rate. Ribbon blenders can be used for this process, if the product is a dust or a dust concentrate. However, a tumbler blender is preferred for impregnating granular carriers, as ribbon blenders tend to break down the granules and cause an excessive amount of fines in the product.

Plant operation

Good plant design is essential to the efficient and safe operation of a formulation plant. In the preparation of certain products, such as wettable powders, it may be necessary to process the material several times, passing it in sequence through a pre-blender, hammer mill, air mill, cyclone separator, after-blender, and packer. A plant should be designed so that the product passes from one stage to the next in a closed system with little or no handling.

There is another aspect of plant design which is worth noting. The plant should be designed so that it is easy to keep clean, and so that it is a safe place to work. Cleanliness and safety go hand in hand, as the type of dust and dirt that accumulates is likely to be toxic. Pesticides can be dangerous when improperly handled; however, the industry has a fine safety record.

In actual plant operation, the most efficient throughput rate is sought, but at times it is necessary to run at maximum rates. This is a result of the highly seasonal nature of the agricultural pesticide business. Insect infestations on crops occur only at certain times of the year, and they may be light or heavy infestations. The possibility that there may be no infestation at all makes formulators, jobbers, and dealers reluctant to stockpile more than small inventories of their formulated products. Furthermore, the composition of the formulation can vary with the type of infestation, often requiring two or more toxicants in the blend. Consequently, formulation plants are usually considerably overdesigned so that they can put out a years production in the space of a few months.

A complete formulating plant for agricultural pesticides should be equipped to handle both solids and liquid formulations. Typical flow sheets for such operations are shown in Figures 1, 2, and 3. The cost of a plant varies widely depending on whether they serve a narrow or a wide diversified end use. A new completely equipped formulation plant capable of producing 200,000 lb./day should cost roughly $1,500,000. However, many plants are the result of a slow growth using second hand equipment.

Obviously, if someone else does the basic research, toxicology, label requirements and formulation studies, it is relatively easy to get into the formulation end of the business. The problem is to stay.

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Regulations and future trends

Before a formulator can legally sell his product, he must comply with certain laws regulating its sale. If it is to be marketed in interstate commerce, the formulation must be registered with the federal government and a sample copy of the product label must be filed. The initial registration of the pesticide for its various applications will have been taken care of by the manufacturer of the basic pesticide during the development stage. The problems involved in the registration of a pesticide for a new use are many, and a description of them is not within the scope of this article. Specific use data and residue data are not required for each different formulation.

Other regulations with which the formulator must comply are those concerning the shipment of hazardous materials. Pesticide formulations may be either flammable, poisonous, or both. If so, the regulations designate the types of packages which may be used, the warning statements they must carry, and the restrictions on how they may be shipped.

Just as the basic pesticide business is becoming more complicated by virtue of the increasing number of compounds being offered, many for rather specific end uses, so also is the formulating side. Not only must the formulation be fitted to end use and product, but new goals have been introduced. Often, it is possible through formulation to modify the basic toxicant so as to either extend its area of useful application to related fields or to totally new uses.

Of particular importance is residual activity. In many cases, a pesticide would be far more effective if it could be made to stay on the treated surface longer. It should be possible to extend the life of the residues of certain volatile compounds considerably by incorporating into the formula agents which will repress their evaporation. Researchers have shown that this is indeed possible with lindane, and to a lesser degree, with some other insecticides, through the use of certain resins. On the other hand, the residues of some toxicants remain on the treated surfaces longer than is desired. It also should be possible to formulate such chemicals so that their residues will start to dissipate within a certain length of time after application. The usefulness of many pesticides could be increased enormously through controlled residual activity.

Another way in which formulations might be of greater benefit would be in the reduction of mammalian toxicity. Many insecticides have a high toxicity to mammals, as well as to insects. It is certain that such compounds would find greater acceptance if their toxicity to humans could be controlled by the form in which they are eventually applied. Formulators have already taken steps to make some of their formulations safer and have met with limited success. Much remains to be done in this field.

Through such techniques as encapsulation, control can be obtained on the release rate of a chemical to entirely change its normal physical characteristics.

Major research efforts on formulation techniques can hardly be justified by the small independent formulator, nor does it appear that the government is in a position to undertake this work. Logically, this field belongs to the manufacturer of the toxicant. For a healthy development of the industry, these research costs must be included in that of the toxicant and the purchaser should recognize this when choosing between alternatives.

Low Temperature—II

Since the first commercial air liquefaction plant there have been probably hundreds of major accidents in units of this kind. Generally, the causes have centered around relatively few specific conditions. First, the particular properties of acetylene; second, the marked increase in the activity of oxygen at high concentrations and third, the low temperatures involved which erect barriers to detecting and correcting unusual conditions.

The following articles represent case studies of actual accidents. The advantages of this treatment are: first, we have a connected story for a particular installation; second, it's somewhat easier to follow than a series of comments on parts of different plants; third, it demonstrates how much can be learned by technical detective work; and fourth, it shows the interrelationship between various safety aspects of a plant.—**R. W. Rotzler**

Compressor explosion

C. W. Gibbs
Ingersoll-Rand Company

Investigation of damage caused by an explosion during a routine test warns compressor operators against explosive oil-air mixtures.

The only major disaster in the 88-year history of the Ingersoll-Rand Co. occurred recently during a routine shop test of a centrifugal booster compressor at the Phillipsburg, N.J. plant. This accident claimed the lives of 6 men, hospitalized 6 more for varying periods of time, and slightly injured 24 others.

Although this incident did not occur in an air separation plant or an ammonia plant, a description of the accident in this safety session is of value if it should serve as a warning for similar plant operations.

An investigation committee was created immediately to find out what caused the accident and to make recommendations to insure against any recurrence. This committee was composed of engineers from Ingersoll-Rand selected because of their experience and intimate knowledge of the equipment involved in this situation. They were assisted in their exhaustive studies by A. L. Brown, an expert on industrial explosions. In addition, various industries were approached to get the experience of others who might contribute to the thoroughness of the investigation.

The compressor being tested was the high pressure stage of a two stage unit which was part of an installation for an oil field at Kuwait. The installation was designed to compress natural gas for injection into the ground to accelerate the flow of oil from adjacent wells. The compressor was similar to a number that have been built by Ingersoll-Rand for many different petroleum and chemical industry applications and for nearly identical repressuring service on Lake Maracaibo, Venezuela. It was to be driven by a gas turbine coupled to a speed increasing gear. The compressor requires about 6000 hp to attain its rated performance.

Testing procedure

The test on this compressor was a standard and accepted method used to assure that the unit met all mechanical and performance requirements. It has been used widely throughout the industry for many years. This compressor had been run several times prior to the accident to prove it out mechanically. Other than vibration that was corrected prior to the final tests, the compressor ran well. Eye witnesses could report nothing unusual in the operation of the compressor. It had been running about six hours that day.

The test setup which is of interest is shown in Figure 1. Testing is done on a platform on which a special 22,000 hp steam turbine driver was permanently mounted, and served by a condenser located beneath the platform. A speed-up gear is driven by the turbine and the compressor on test is coupled to the gear output shaft.

Instruments for measuring speed, temperatures, pressures, and water flows were incorporated as required at various points in the testing loop.

A closed loop system (Figure 2) using air under pressure simulated the field conditions. The air leaving the compressor travels through a short length of pipe and then passes through a long tubular cooler in which water is circulated outside of the tubes to remove the heat of compression. After the air has been cooled to about room temperature—in this case 85°F—it passes through a high pressure throttle valve which reduces the pressure to inlet conditions. The throttle is adjusted by a test engineer to establish the desired discharge pres-

sure and flow through the system. Before the air returns to the compressor inlet, it passes through a long length of straight pipe at the end of which is a nozzle-shaped orifice used for measuring the quantity of air flowing through the system. After passing through this measuring nozzle the air traverses another length of straight pipe and then turns upward to the inlet opening of the compressor. All of this closed loop piping was located underneath the compressor and platform.

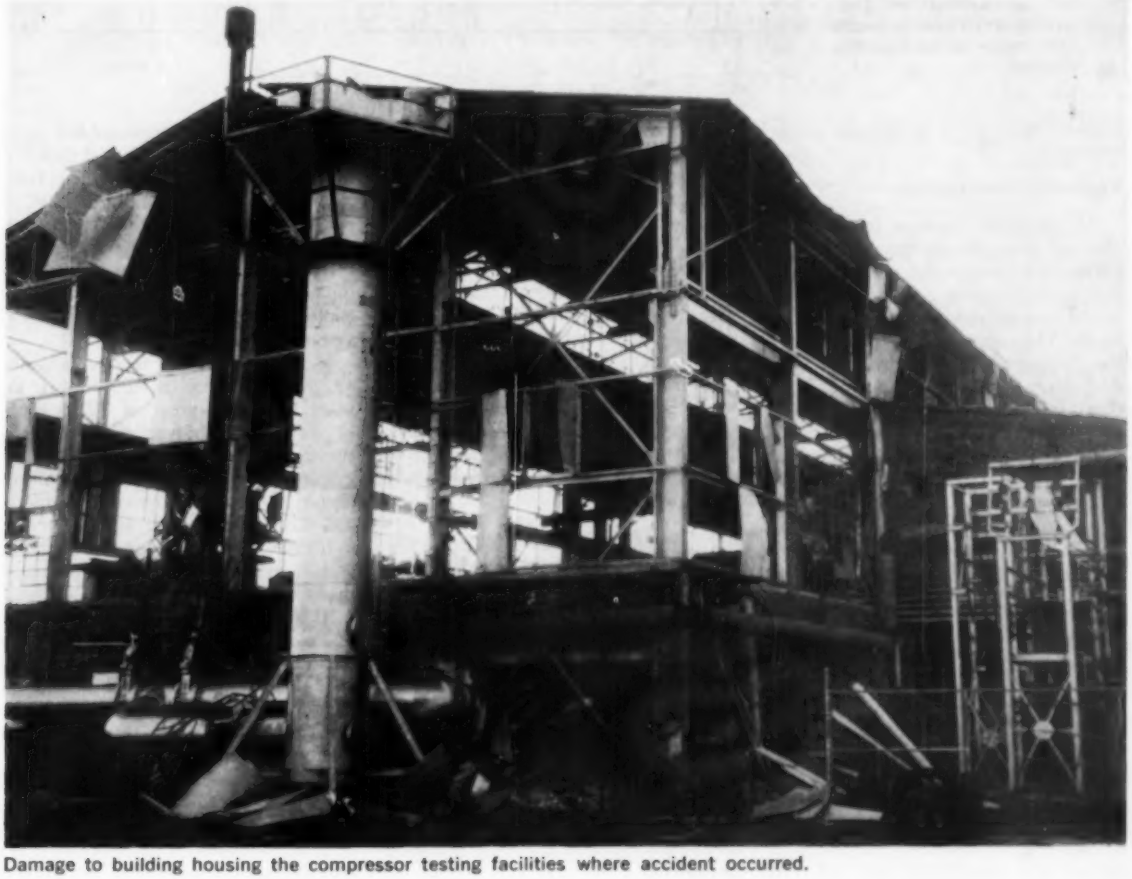
The loop piping was heavy seamless steel. The bursting pressure in the low pressure section was calculated to be approximately 7450 lb./sq. in. which gives a margin of safety of about twelve times the operating pressure of 600 lb./sq. in. In the high pressure piping the calculated bursting pressure at the weakest point is 11,000 lb./sq. in., providing a margin of safety of about six times the operating pressure of approximately 1700 lb./sq. in. No destructive detonation rupture occurred in this high pressure section of the loop system. The entire test loop had been hydrostatically tested immediately preceding its use for this test.

When air or any gas is compressed, its temperature increases, and limits based on long experience have been set for allowable discharge temperatures. In this case a maximum temperature of 400°F was established prior to the test.

Water supplied to the cooler was arranged to operate from a main on the same circuit which supplied the water to the steam condenser. There was no loss of water supply to the cooler.

As a precaution against foreign matter remaining in the test loop, a drainage pocket and other drains are located at the bottom of the piping system. Accumulated water and any oil present were removed before each test run by blowing down with air until no accumulated liquid was observed in the discharge from the drains.

In a test system using dense air it is necessary to charge the system and also to maintain the prescribed inlet pressure—in this case about 600 lb./sq. in. An auxiliary compressor system consisting of a booster compressor supplied the necessary air through a small pipe to the test loop. A man at the test pit regulated the amount of air supplied by a small valve so as to maintain the desired inlet pressure. Standard procedure, which was observed, calls for blowing down the high pressure receiver near the booster compressor (technically known as a bottle) to remove moisture and lubricant continuously. Careful examination of this charging compressor system established definitely that



Damage to building housing the compressor testing facilities where accident occurred.

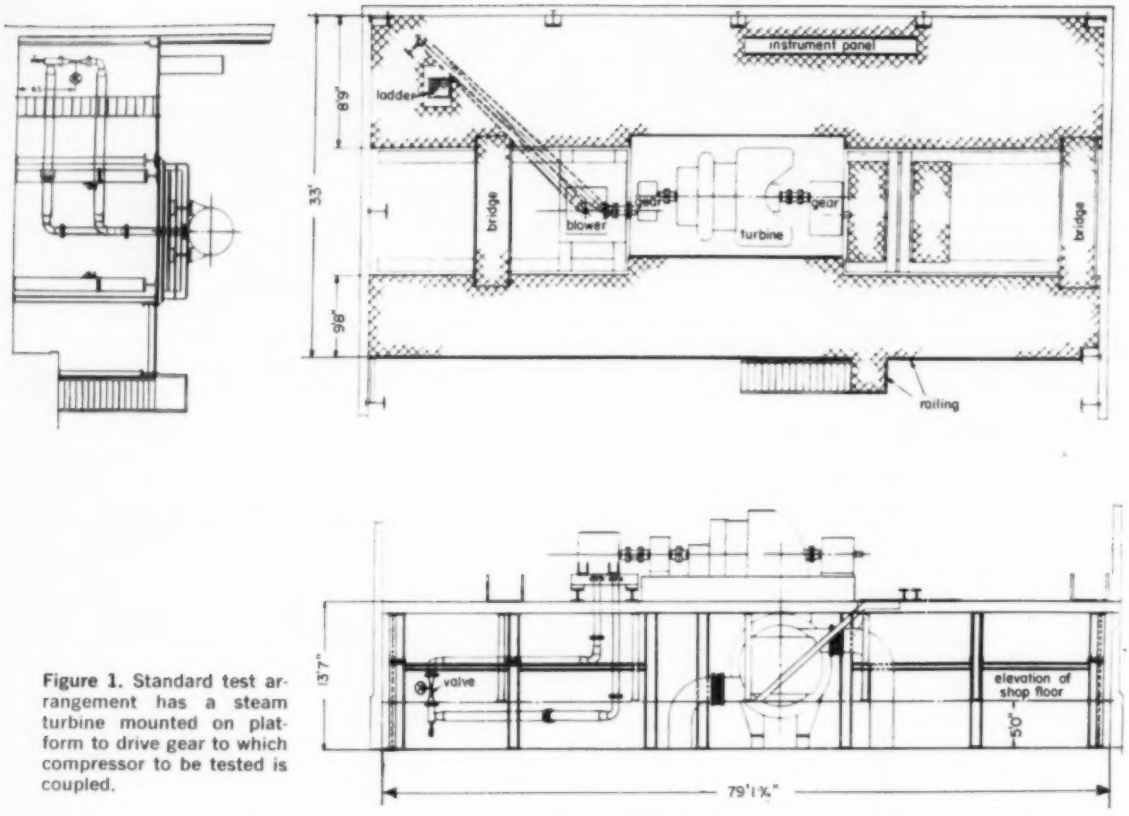


Figure 1. Standard test arrangement has a steam turbine mounted on platform to drive gear to which compressor to be tested is coupled.

it did not cause or contribute to the explosion.

Explosion description

All physical damage in the area resulted from the ruptures caused by detonations within the cool low pressure piping at two points in the horizontal run at the bottom of the test loop. The approximate locations of the ruptures are indicated on the diagram at points "X" and "Y". A third failure occurred at point "Z", but this was due to the severe bending force imposed by the detonations at "X" and "Y" rather than a local detonation.

An external view of the building shown in the introductory photograph will give you an idea of the damage done. Figure 3 shows the area where the test loop had been beneath the platform.

The committee assembled all of the parts that could be retrieved and studied them exhaustively. At point "X" on the diagram the heavy 12-in. pipe had been ruptured so that it was opened up like a banana peel. A detonation or explosion pressure of extreme intensity undoubtedly occurred in this region. Evidence of soot supported the conclusion that oil was present and had combined with the compressed air to form a combustible mixture.

At point "Y" in the diagram a second severe rupture occurred giving a similar banana peel appearance to the exploded pipe. In between the two ruptures a long secton of pipe was intact. This condition is typical of ruptures caused by detonation waves. They create a region of very high pressure, ignite and explode, and then travel at relatively low speed to a new region where this is repeated. This may be followed by successive waves of pressure at intervals along the pipe.

C. W. Gibbs has been with Ingersoll-Rand for 43 years, except for two years with Babcock & Wilcox and one year of Navy service during World War I. Most of his work with the New York company has been with special applications and process compressors. In recent years, Gibbs has been connected with the Compressor Engineering Department. He has been particularly involved with work on compressors for synthetic ammonia production.

In studying the reassembled parts positive evidence was found that the detonation wave had traveled from right to left on the diagram. This, of course, is opposite to the direction of the normal flow of air in the loop system. The findings also localized the damaging detonations in the cooled low pressure part of the loop system.

It is known that the low pressure air in the system at 600 lb./sq. in. was at a temperature of 85°F. Fires in compressed air systems occur occasionally and are practically always associated with the high temperature region at the discharge of a compressor. This fact is well known to the industry. Here, however, the ruptures and damaging detonations occurred in low temperature regions and not in high temperature regions. In view of the direction in which the pressure wave apparently traveled, it could only be concluded that a fire occurred somewhere in the compressor and the resultant shock wave traveled down the low pressure piping, gathering momentum until it detonated at the first point of rupture marked "X" on the diagram.

The compressor itself appeared externally unharmed. The heavy forged

Figure 3. The extent of the damage to the test loop beneath the platform is shown in photograph taken immediately after the explosion.

steel casing and the inlet and discharge nozzles were all intact. The coupling which attached the compressor to the high-speed pinion shaft was completely broken and the pinion shaft was twisted, bent, and broken. The gear housing was also ruptured.

Internal damage to the compressor and its movement, caused by the explosion is believed to have created misalignment between the compressor and the gear, resulting in the coupling failure. The broken coupling on the gear could have produced sufficient unbalance to cause failure of the pinion shaft. This was the opinion of General Electric experts who assisted the committee. It was concluded by the committee that the damage to the coupling and the gear which drove it was a result of the explosion, not a cause.

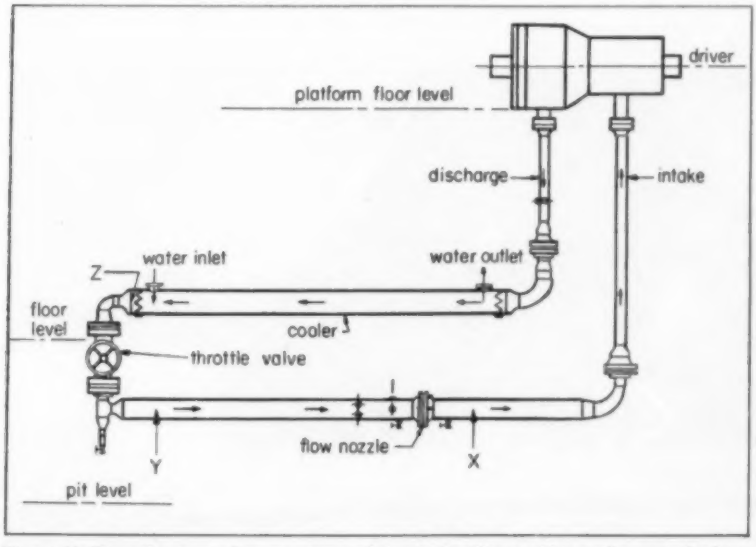


Figure 2. Flow diagram of compressor piping indicating sections where explosion damage occurred.

Conclusion

After examination of the loop piping and the external parts mentioned above, the compressor was dismantled in the presence of the committee and the insurance companies. Many of the parts were damaged to such an extent that it was impossible to determine their condition just prior to the explosion. The oil seals that prevent the air or gas from escaping from the shaft opening in the compressor were in satisfactory condition as were the bearings. A few parts were rebuilt and tested in an attempt to duplicate the condition in which they were found after the accident. We were not able to duplicate the fractures.

After studying the results of these tests the committee concluded that the extreme damage to these parts could have occurred only as a result of the explosion. The committee decided, after studying the evidence, that it was probable that the ignition of an oil-air mixture occurred in the compressor. However, the condition of these parts made it impossible to determine the precise starting point and sequence of events.

The investigating committee was also instructed to make recommendations to insure against a recurrence of this accident. The recommendation was made and immediately put into effect that an inert gas, which will not support combustion, be used in place of air in all future testing of centrifugal compressors where it is possible for combustible materials to enter the closed loop. This we feel certain will prevent a recurrence.

Another point, emphasized by A. L. Brown, is the need of further knowledge regarding the effects of pressure and recycling on lubricating oils. Existing data, based on laboratory tests at atmospheric conditions, are not reliable for guidance in a closed loop test system or any similar system.

ACKNOWLEDGMENT

Ingersoll-Rand sincerely appreciates the help and interest of the following companies in assisting this investigation: Shell Chemical, Foster Wheeler, Allied Chemical, Standard Oil (Ind.), Esso Research and Engineering, DuPont, Air Products, Sun Oil, General Electric, as well as many others.

R. W. Rotzler and J. A. Glass
Monsanto Chemical Company
W. E. Gordon and W. R. Heslop
A. D. Little, Inc.

Oxygen plant reboiler explosion

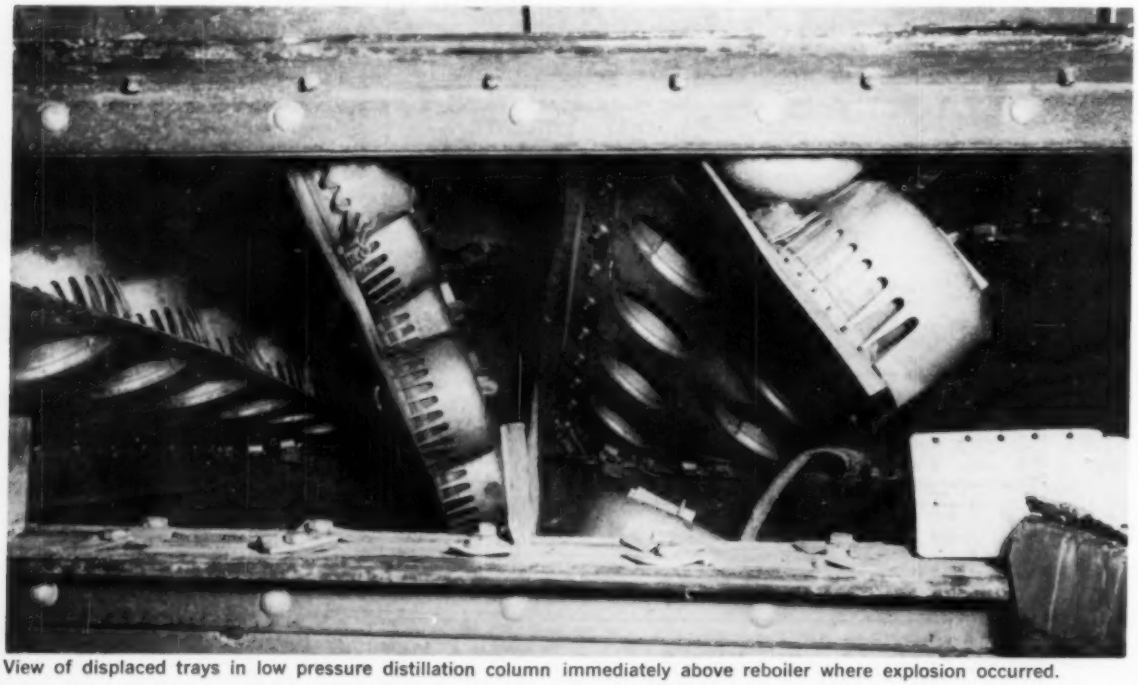
Laboratory study of plant clues indicate a co-crystal of acetylene and nitrous oxide, which built up over a six month period at the bottom of the reboiler, caused plant mishap.

On January 11, 1956, a reboiler explosion occurred in the large tonnage oxygen plant of Monsanto Chemical Company at Texas City, Texas. There were no personnel injuries and no ruptures of lines or vessels. Reboiler tubes were extensively damaged, however, and trays in the associated distillation column were displaced. Repairs required several weeks.

The oxygen unit produces gaseous oxygen at 95% purity plus a relatively small stream of high pressure nitrogen. The oxygen is used principally for the partial oxidation of natural gas to acetylene, which in turn goes to adjacent acrylonitrile and vinyl chloride units. The nitrogen is used throughout the plant as an inert gas for purging.

The process employs a low pressure cycle. A simplified flow diagram is shown in Figure 1. Incoming filtered air is compressed with centrifugal machines and cooled in reversing exchangers. Fractionation is carried out in the conventional double column; the two columns and the reboiler-condenser between them are built as an integral unit. Liquid rich air from the high pressure column, after subcooling, passes through a silica gel bed on its way to the low pressure column. Refrigeration is provided by an expansion turbine operating on uncondensed overhead from the high pressure column.

The unit first went into operation in 1952. At the time of the explosion it had been in operation for about 9 months since the last complete warm-up and cooldown. Six months before the explosion, however, it was shut down in a cold condition for me-



View of displaced trays in low pressure distillation column immediately above reboiler where explosion occurred.

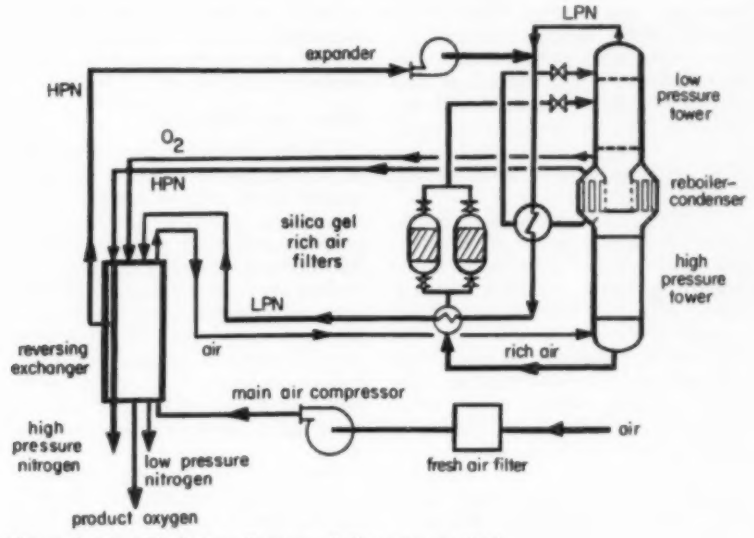


Figure 1. Simplified flow diagram of the oxygen plant.

Figure 2. Typical example of tube from reboiler that had been crushed by explosion.

chanical repairs and restarted 5 days later without rewarming.

Operation in the days immediately preceding the explosion was completely normal. The silica gel filter was in service and acetylene content of the reboiler by routine sample taken the day of the explosion was several orders of magnitude below the saturation limit. The adjacent acetylene unit, the most likely source of dangerous air contamination, was completely shut down at the time and had been for the preceding 24 hr.

Reboiler explosion

The explosion was evidenced by a rumbling sound. Pressure pens on recording instruments swiped the chart and oxygen purity decreased sharply and considerably. Paint on the tower foundation bolts was cracked, but there was no external evidence of damage. The plant continued to operate at reduced purity until shut down in an orderly procedure.

Detailed examination of the equipment after warmup showed the most extensive damage to have been sustained by the reboiler tubes. About 70% of the approximately 25,000 tubes showed some damage; about 31% showed severe damage. All tubes affected showed the same deformation pattern, which varied only in degree; they were crushed by extreme external pressures, highly localized, just above the bottom tube sheet (Figure 2). Damage was generally more pronounced near the periphery of the tube bank (Figure 3).

About half the pressed-metal trays in the low pressure column were wholly or partly displaced upward (see introductory figure). Displacement severity decreased in a regular pattern upward through the column.

The reboiler tube sheets, the reboiler, and tower shells were not detectably deformed.

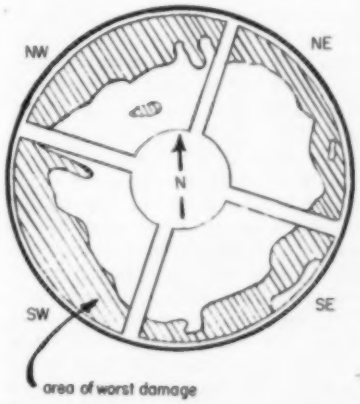


Figure 3. Horizontal cross-sectional diagram of reboiler showing areas of severest damage.

From the over-all damage picture, it was concluded that the total explosive force was equivalent to that of about 2 lb. of TNT (or 1 lb. of acetylene). The local pressures of several hundred thousand lb./sq. in. necessary to deform the tubes in the way described could only have been produced by the detonation of a condensed (liquid or solid) material. Consideration of the location of the tube damage, the great number of tubes involved, and the relatively small weight of explosive, leads to the conclusion that the material was distributed in a very thin layer that lay quiescently on the bottom tube sheet. Only a very sensitive explosive material would be expected to detonate in this manner. Tray damage is thought to be a secondary effect resulting from sudden vaporization of liquid oxygen.

Investigation of possible causes was facilitated by the fact that the plant was still more or less intact. Residue found on the bottom of the reboiler was analyzed, as was the silica gel bed for absorbed materials. During normal operation after the explosion, various plant streams were extensively analyzed for contaminants, which were detected in fractions of a part per million.

As various clues were picked up from the plant studies, laboratory studies were undertaken to test the

low temperature physical and explosive properties of various materials revealed by the plant investigation. Operating procedures prior to the explosion were examined to determine how the various materials might be brought into the reboiler.

Basically, the investigation had to answer three questions:

1) What was the explosive fuel?
2) How did it get to the reboiler?
3) Why did it explode when it did?

Explosive fuel investigation

It was concluded that co-crystals of acetylene and nitrous oxide (N_2O) formed the fuel.

Acetylene was suspected from the first. It is an ever-present contaminant in air plant inlets, even without an acetylene unit next door, and was, of course, found in the silica gel bed just after the explosion. Solid acetylene in liquid oxygen meets the requirements set for sensitivity and violence. However, solid acetylene tends to float in liquid oxygen. It was necessary to find an anchor for the acetylene that would hold it on bottom of the reboiler (and thus keep it from getting into the regular reboiler sample for acetylene analysis) without appreciably affecting its explosive sensitivity.

Nitrous oxide (solid) provides such an anchor. It was found unexpectedly in the silica gel bed just after the explosion, and its regular presence in rich air and reboiler blowdown has been confirmed during plant operations since. It may arise from the flaring of nitrogenous wastes in the adjacent acrylonitrile unit or from more normal combustion processes.

In the laboratory, co-crystals of acetylene and nitrous oxide were found to sink in liquid oxygen (at its normal boiling point) if they contain less than 50 mol % acetylene. Co-crystals containing more than 25 mol % acetylene were found to be easily detonated. Thus crystals with between 25% and 50% acetylene both sink and detonate.

To carry out the tests, gaseous mixtures of various ratios of acetylene and nitrous oxide were made up at room temperature and blown through a glass tube onto the surface of liquid oxygen in a test tube which was surrounded by liquid oxygen in a Dewar (Figure 4). Cautious shaking overcame surface effects, and rather clearly defined limits of sinking or floating were obtained.

The equipment was modified slightly for the explosibility tests. The entrance tube dipped below the surface of the liquid oxygen. A 4-grain pyrotechnic squib was inserted loosely into the lower end of the entrance tube. After the gaseous mixture was introduced, the deposited solids were tamped lightly with a wooden rod (Figure 5). Tamping was necessary to get effective results. The Dewar was removed and the squib fired immediately. Both sets of experiments were safely carried out in a steel safety chamber with observation ports.

Similar results were obtained in drop-weight tests. The anvil of the drop-weight tester was cooled with liquid oxygen; the various gaseous mixtures were deposited on the anvil; and the anvil was then flooded with liquid oxygen. A 3000-gm. weight and 100 cm. drop height were used. These conditions were sufficient to detonate solid acetylene in liquid oxygen in the drop-weight apparatus used. Solid mixtures containing up to 75 mol % nitrous oxide in acetylene showed the same sensitivity to detonation as did pure acetylene.

To more closely approach plant conditions, a further test was made with a reboiler mock-up. Twenty one tubes similar to those used in the plant were set in holes in a brass plate (same spacing as in the plant) and held there with plaster of Paris. This assembly was placed in a 12-in. diam. can, which in turn was set in a 24-in. diam. can in a hole in the ground. The outer can was filled with liquid nitrogen. A layer of 60 mol-% nitrous oxide and 40 mol-% acetylene, about 1 mm. thick, was condensed on the "tube sheet" in the small can and tamped lightly. Several inches of liquid oxygen were added to the inner can, and the mixture was fired with a No. 6 detonator cap. Results were surprisingly violent and gave a damage pattern similar to that in the plant explosion (Figures 6 and 7).

Other fuel potentials

Carbon dioxide, which also sinks in liquid oxygen and is regularly present in the reboiler beyond saturation limits, was also considered as a possible anchor for acetylene. Using lab techniques similar to those described above, it was found that acetylene-carbon dioxide co-crystals sink if they contain less than 50 mol % acetylene. Co-crystals detonate only if they contain more than 60 mol % acetylene, however. Thus, no mixtures were found which both sink and detonate.

Soot was also an early suspect as a fuel. Small quantities were found in the reboiler residue after the explosion. Laboratory tests indicated that soot-liquid oxygen mixtures will indeed detonate, but these mixtures are considerably less sensitive than the acetylene-nitrous oxide-liquid oxygen mixtures. Soot saturated with acetylene showed the same sensitivity as soot alone. Although soot represents a real hazard in an oxygen plant reboiler, tests showed it to be a much less likely fuel for the explosion being investigated than did acetylene-nitrous oxide.

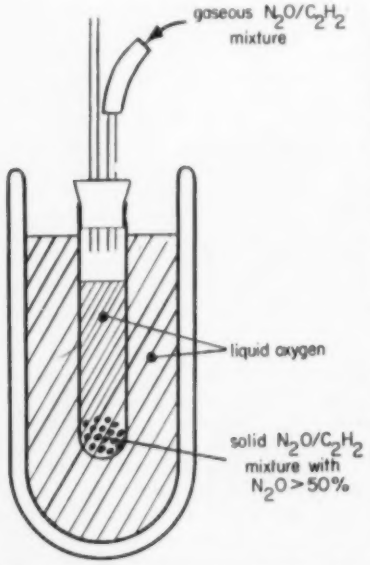


Figure 4. Laboratory apparatus for determining the density of mixtures of acetylene and nitrous oxide in liquid oxygen.

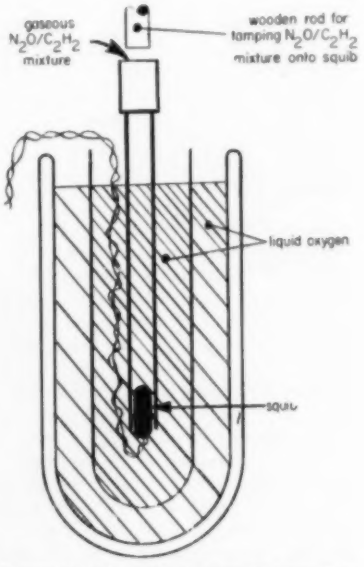


Figure 5. Laboratory apparatus used to experimentally determine the explosibility of mixtures of acetylene and nitrous oxide in liquid oxygen.

Silica gel dust was also found in the reboiler residue and the possibility of this dust saturated with acetylene as a fuel was considered. Russian workers have established that gel beads saturated with acetylene will not explode in liquid oxygen (*1*). Laboratory tests were run using a finer (28-200 mesh) gel. No explosions were obtained, either with a detonator cap or in drop-weight tests.

The question of a secondary role of nitrous oxide—as oxidant or explosive in its own right, rather than mere diluent—remains open. Previous work (*2*) produced explosions of pure gaseous nitrous oxide at ambient temperature, but failed to produce an explosion of the solid in liquid oxygen. In the drop-weight tests, no explosion was obtained with solid nitrous oxide at liquid oxygen temperatures in the absence of liquid oxygen. Similarly, a 50-50 mixture of solid nitrous oxide and acetylene without liquid oxygen failed to explode, although it exploded readily in liquid oxygen. However, in view of the narrower range of explosibility for carbon dioxide-acetylene solid mixtures, a secondary role for nitrous oxide cannot be ruled out.

The nature of the co-crystal is also a question. It is thought to be a simple physical mixture resulting from crystallization of both substances on the same nuclei, not a solid solution. At any rate, acetylene shows the same solubility in liquid oxygen whether the solid phase is pure acetylene or a co-crystallized mixture.

Fuel path to reboiler

The conclusion about the fuel would be more credible if a reasonable explanation could be made of how it got to the reboiler.

It was concluded that acetylene and nitrous oxide were introduced into the reboiler together by partial regeneration of the silica gel bed during start-up following the cold shutdown 6 months before the explosion.

A clue strongly associating these events, even though they were separated by 6 months, was the history of reboiler acetylene analyses during this period. During normal start-ups, the silica gel bed is bypassed until a liquid inventory is obtained. As a consequence, the first reboiler analyses are high in acetylene (up to 2 ppm). This concentration falls rapidly after

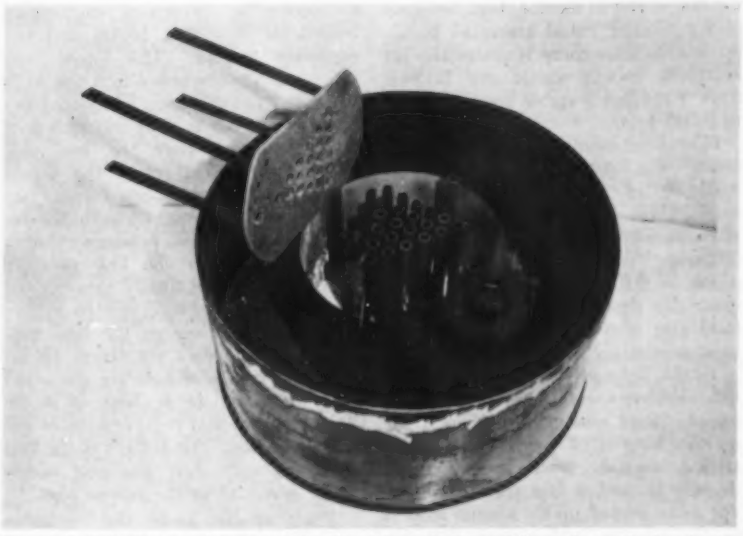


Figure 6. Reboiler mock-up used to simulate actual conditions in explosion tests.

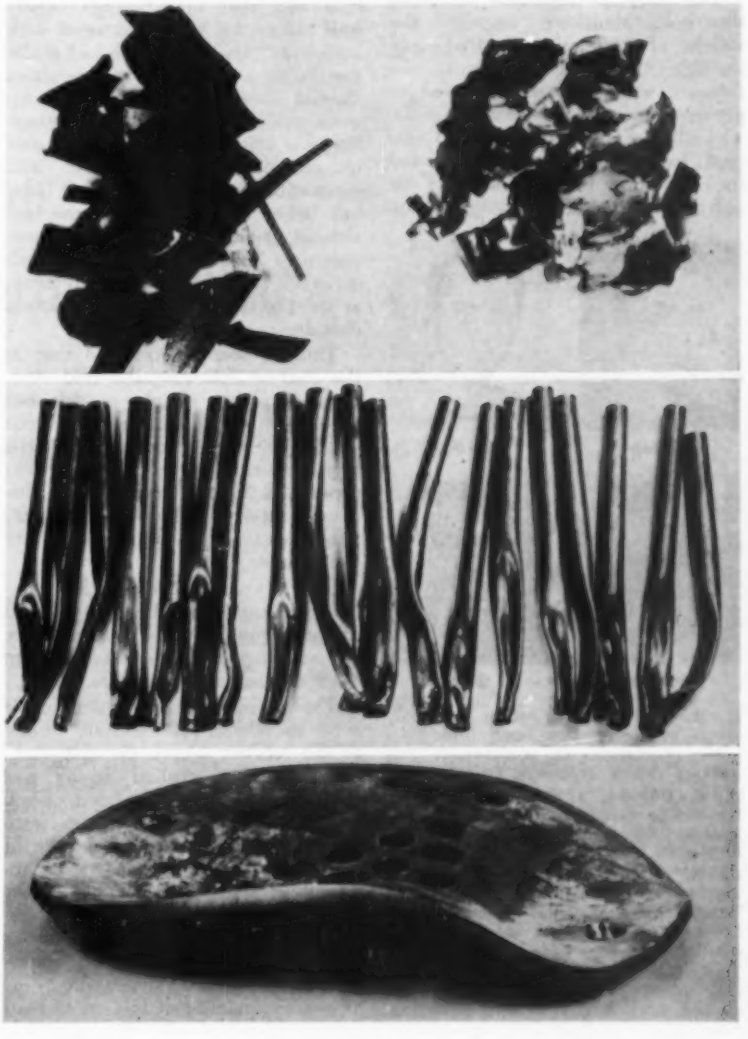


Figure 7. Damage to tubes and plate in reboiler mock-up test. The upper part of the picture shows fragments of the outside (left) and inside (right) cans.

the bed is put in service, both because of the reboiler liquid inventory build-up and because there is essentially no acetylene input; within one to two days it reaches a stable level of 0.003 to 0.005 ppm.

However, following the cold shutdown the pattern was different. Analyses of 0.005 ppm were not reached for 8-10 days. Even thereafter, results were erratic; during the following month some showed as much as 0.070 ppm. The variations gradually decreased, both in magnitude and frequency during the next two months.

In the light of present conclusions, this behavior is reasonable. The sample point was near, but not right on the bottom of the reboiler. The settled crystals were probably not densely packed at first and were more apt to be stirred up by normal motion in the reboiler and carried into the sample stream.

The start-up procedure following the cold shutdown suggests the source of contaminant. Part way through the cold shutdown, the columns were drained of liquid to prevent excessive acetylene build-up. The silica gel bed remained full (except for normal evaporation), and its liquid inventory was used as the source of refrigeration during start-up to cool the reversing exchangers before air flow was begun and the expander started. The liquid was pressured (backwards) into the high pressure column using nitrogen from an external source. The nitrogen flow was continued after the bed was empty, bubbled through the liquid now in the bottom of the column, up through the column, through the reflux line into the low pressure column, overhead through the low pressure nitrogen line, and finally through the reversing exchanger (refer to Figure 1). Gas flow through the bed continued in this way for about 10 hr. Although sufficient data are not available for complete analysis, it is believed that partial regeneration of the gel took place. The bottom of the bed remained cold, but warming necessarily occurred in the upper part.

Plant studies since the explosion show that the silica gel bed absorbs considerable nitrous oxide in typical runs and that breakthrough occurs well before the bed is saturated with acetylene. Analyses of the bed outlet gas during a number of regenerations showed small concentrations of nitrous oxide as soon as the regeneration was started. Acetylene appeared in considerably smaller but still measurable quantities somewhat later, but before the cold end of the bed showed detectable increase in temperature. Peak concentrations of both materials occurred considerably later, as did the first appearance of carbon dioxide.

Thus, it seems reasonable that in the start-up following the cold shutdown, a mixture of nitrous oxide and acetylene (predominantly nitrous oxide) was carried as a gas into the high pressure tower, where it was condensed in the liquid pool, ultimately exceeding the solubility limit. Subsequent operation carried it into the reboiler.

Only a small fraction of the acetylene capacity of the bed would need to have been desorbed to account for the quantity of explosive believed to have detonated.

The possibility of precipitation of solid acetylene (and nitrous oxide) in the reboiler during the cold shutdown, before residual liquid was drained, was also considered. Even assuming the reboiler contents saturated with acetylene at the time of shutdown, and all this acetylene retained in spite of the draining, the quantity of fuel is entirely inadequate to explain the damage caused by the explosion.

It also seems unlikely that the necessary quantity of fuel could have accumulated during normal operations without detection in the frequent routine reboiler analyses.

Residence time

There is still the question of timing —how the acetylene-nitrous oxide mixture remained 6 months in the reboiler without redissolving. If it be established that it did remain, a further question is how it stayed so long without exploding. The answer to the first question gives a clue to that of the second.

It was concluded that the rate of solution of solid acetylene in liquid oxygen is extremely slow because of its very limited solubility, which is the driving force for diffusion through the liquid film surrounding the solid. Nitrous oxide is about 27 times as soluble as acetylene, on a mol basis, according to literature values (*3, 4*); by the same reasoning, it dissolves proportionately faster. The solids when first laid down were predominantly nitrous oxide; an estimate is 90 mol %. They were therefore nonexplosive. As both components slowly redissolved, but at markedly different rates, the composition of the remaining solid changed to become richer in acetylene, until it reached the explosive range. Thus, a substantial delay after original deposition of solids was not only possible, but also necessary.

A mathematical approach to rate of solution indicated something like 6 months would be required to dissolve a solid layer of acetylene 1 mm. thick (liquid oxygen flowing slowly past one side). By comparison, ten days would be required for nitrous oxide, and copper sulfate in water would take only 30 min.

A number of laboratory experiments were run to check this conclusion in principle. Acetylene was deposited as a solid on the side of a Dewar containing liquid nitrogen. The nitrogen was drained off and liquid oxygen immediately added. After vigorous stirring for 1 hr. no acetylene was found dissolved in the oxygen, by Illosvay analysis.

If liquid oxygen contacts acetylene vapor, as in the crystal density experiments, or by letting the Dewar warm up partially before the liquid oxygen is added in the test just described, the oxygen is saturated with acetylene.

Other explanations for the delay are possible, such as time required for the crystals to reach a critical packing density, or lack of initiation. In any case, a very slow rate of solution of solid acetylene must be assumed. The conclusion given goes a step further in accounting for predominantly nitrous

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oxide crystals originally deposited, as evidenced by bed regeneration studies, changing composition to become explosive.

Initiation, of course, would time the instant of explosion. No investigation was made of possible sources of initiation. A number can be suggested, but the task of pinning down which particular one did this job appeared both near-impossible and singularly unrewarding.

Conclusion

The theory presented is considered a probable cause of the Monsanto reboiler explosion and takes account of all pertinent facts uncovered in the investigation. It cannot be proved rigidly, however, without undue expense.

It would be interesting to know the extent to which nitrous oxide is found as a contaminant in the inlet air to other oxygen plants. It is relatively easily detected during silica gel regeneration. If it is generally or occasionally present, it may help account for other explosions verbally reported to have occurred at the bottom of the reboiler.

Together with ever-present carbon dioxide, it may represent some measure of safety, since both compounds form co-crystals with acetylene which sink, if the acetylene content is not too great. A further necessary condition is that the reboiler (or column sump) be so designed that solids do not accumulate there, but may be regularly removed and disposed of outside the plant. The Monsanto unit has been modified in this way.

The slow rate of solution of acetylene has considerable significance in interpreting the results of reboiler analyses. A rise in acetylene concentration in the reboiler needs to be discovered and corrected before saturation is reached. Once acetylene crystals are formed, they may continue to exist without appreciably affecting the concentration of dissolved acetylene after this concentration has returned to normal.

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Safety in air and ammonia plants

. . . additional case studies and discussion developed at the Symposium

P. W. REYNOLDS—Imperial Chemical Industries, Billingham: A serious accident occurred on April 21, 1959, in a 240 tons/day oxygen plant which was being started up in England at Billingham. Without any warning, one corner of the coldbox was wrecked by an explosion. Although the actual explosive charge was small, the damage was quite extensive. The detonation was extremely violent. Three men were killed.

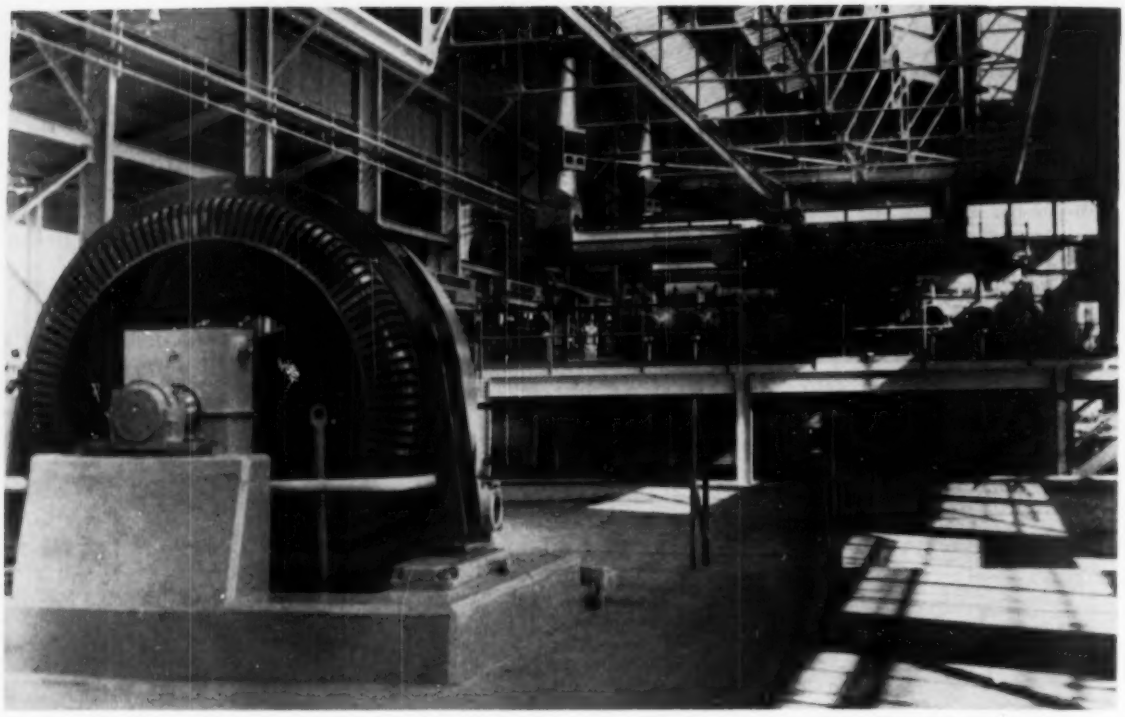
The accident was intensively investigated by a team of 40 chemists and engineers supplied by I.C.I., Air Products Inc., and Air Products (Great Britain) Ltd. Professor Newitt, head of the Chemical Engineering Department of the Imperial College of Science and Technology in London, acted as an independent consultant.

The plant was being commissioned when the accident occurred. It was quickly established that the whole plant was running under good conditions. There were no peculiar releases of hydrocarbon or acetylene from other plants. All the measurements had been properly taken. An additional hydrocarbon instrument had actually been installed on this very day and had shown repeatedly that the figures for total hydrocarbon were well within the specification. So far as anything inside the plant was concerned, everything had been in order. The only irregularity had been a liquid oxygen leak.

It was established by patient excavation of the debris that the explosion had occurred over a relatively small area, perhaps 3 sq. ft., near the floor in the corner of the coldbox. This area was close to the place where the liquid oxygen leak had occurred. A nitrogen line, which had originally been within 10 in. of the floor, was now pushed up to an apex about 10 ft. above it. This confirmed our conclusion that the explosion had been outside the plant's pipes and vessels. It occurred on the floor of the coldbox or very close to it. While it was obvious that the liquid oxygen was one component of the fuel, it was difficult to see how any combustible could have gotten into the position where the explosion occurred.

The damage caused was equivalent to the detonation of about a pint and a half of lubricating oil spread over rock wool and soaked in a slight excess of liquid oxygen. We think we know where this pint and a half of oil came from. But it was difficult to explain how it got to the site of the explosion.

This plant has turbo-expanders with gear assemblies mounted on bases just outside the coldbox wall in the compres-



Interior view of the anhydrous ammonia plant at American Cyanamid's Fortier plant near New Orleans. In the left foreground is one of the circulator compressors. The nitrogen and synthesis gas compressors are in the background.

sion plant. Oil had dripped occasionally from these gear assemblies on to their bed plates, but not in large quantities. The turbo-expanders themselves were faultless. These small leakages of oil were always meticulously cleaned up, but it is believed that some oil did get down off one of the bed plates and seep into a narrow crevice between the expander assembly mounting base and the coldbox wall. Although there was supposed to be, and probably had been originally before coolings-down and warmings-up had spoiled it, a proper joint between the wall and the concrete, we believe that oil from this source did seep into the position where the explosion occurred.

It seems useful to report this incident because there may be other plants where traces of oil have gotten into the coldbox or where oil exists just outside the coldbox. If there are, a leakage of liquid oxygen could lead to a similar disaster. It is to be remembered that mixtures of liquid oxygen and oil are so notoriously sensitive that even the vibration of the ground can be sufficient to set them off.

FRANK HIMMELBERGER — Air Products, Inc., Allentown, Pa.: What are some implications of the ICI explosion? First of all, the expander location should be spotted at least two feet away from the coldbox, so that there is a visible area between the coldbox and the expander pad. This will minimize the possibility of an unnoticeable crack occurring between the foundation and the coldbox panels, or in the foundation itself. This incident also emphasized the importance of a solid concrete pad, or at least solid construction under the box, so that no cracks are available for oil seepage.

Very rigid rules about oxygen concentration in wool and air plants must be established. We will not tolerate more than 40% oxygen in rock wool and, as a matter of fact, we try to hold it below 25% oxygen. Explosions in rock wool, with gaseous oxygen, are extremely unlikely because the rock wool itself is a diluent.

GORDON WEIGERS—American Cyanamid Co., New Orleans: I might point out that we were also very concerned about the possibility of getting oil into the area of the oxygen plant. We're fortunate in that our expanders are on separate pedestals and the oil would literally have to leap over a four-foot gap. However, one of our operators pointed out that we have a very large compression building adjacent to our oxygen plants and the surface drainage in the area was such that oil spill in the compression building would run right by and between the oxygen plants where, from time to time, it was conceivable that we could have a spill. So, we tore up (I don't know how many) cubic yards of concrete and relaid all our drainage ditches and regraded the area so that there is now a ridge between the coldboxes and the compression area; so that surface drainage cannot mingle between the two areas.

R. E. BUTIKOFER—Standard Oil Co. (Ind.), Whiting: It's common practice in the construction of coldboxes to use wood for bracing inside the box. Very likely everyone of us has some wood inside his air separation coldbox.

D. C. LAMOND — Canadian Industries, Ltd., Kingston, Ontario: Following the ICI explosion, we entered our coldbox first to determine if there was excess oil in our rock wool, or any type of leakage. Then we removed the floor-level wooden structures from the coldbox. We took a great many samples of rock wool, and could find no excess of oil. In our turbine and pump room, we graded the floor away from the coldbox so that oil could not run back into the box.

WALTER LINDE—Linde A G, Toronto, Ontario: We specify the oil content in the wool that is used in our plants to be less than 0.1%. The reason is we figure, that on deriming, we have a concentration of the oil. It evaporates where there is a hot pipe or vessel and it condenses where you have a cold spot. We feel it is better to be safe than sorry.

R. W. ROTZLER—Monsanto Chemical Co., Texas City: The only oxide of nitrogen that we have found is N_2O. We have tested for, but have not found,

either NO or NO_2 in any concentrations that we were able to measure. Now, on the basis of the tests that we have made, the N_2O itself, or even associated with acetylene is not dangerous. It's the acetylene that's dangerous. The N_2O apparently does nothing more than dilute it, and anchor it. In laboratory tests we ran on N_2O-acetylene crystals, we failed to get explosions of N_2O-acetylene crystals without liquid oxygen. With liquid oxygen, there are explosions which are just as violent as if the crystals were pure acetylene, but the N_2O apparently does not contribute much to the explosiveness of the mixture.

Accidents and analyses

WEIGERS—American Cyanamid: We had a most unusual mishap. We were operating our plant in a normal fashion and one day noticed that the pressure in the coldbox wall went up appreciably, and our heat-leak went up. We found ourselves running with more expansion turbines to maintain our liquid levels. We found that we had to cut production to maintain our liquid balance. A big ice spot appeared on one of the walls in the coldbox. At the first opportunity we shut the plant down to inspect it. We took the inspection plate off the coldbox wall in the area immediately adjacent to the ice spot, hoping that we would find a flange leak, or something of that sort. We found the source of the trouble but couldn't imagine how it occurred. A vertical run in the piping from the bottom of the regenerators to the high pressure column, had a dent in it as if someone whaled away at the pipe from the inside with a 100-pound ball-peen hammer. A little lump was formed like a golf ball sticking out of the pipe. Close to this, slightly below, the pipe was worked into a collar-like flange. The pipe was sheared off just across the top of the collar. It certainly looked like a detonation; it had all the indications of a very quick, very-high energy release although, fortunately, the amount of fuel there must have been very small. The thing that intrigued us is, how did it get up into a vertical run?

We're not sure we know the answer yet. There were stones from the regenerators lying in the pipe below, which were not the result of the accident. One possible theory is that during the previous run we could have gotten some solid acetylene on these stones, and that these stones bouncing up in the pipe caused the explosion. We're not at all satisfied with this explanation. It takes too many things for granted. The fact is that we had a minor detonation. The pipe failure was such that it could not be explained by high pressure. There was no evidence of corrosion on this pipe that would lead one to believe that the pipe may have been weakened by corrosion. This occurred at a time when we were running a recording acetylene analyzer on the intake air. We were running a recording total hydrocarbon analyzer on the liquid oxygen in the main condenser and, as is our routine, we were making acetylene analyses every hour-and-a-half. The wind for the previous 36 hr. had been from a direction where there is swamp for 75 miles. There were no diesel engines running near the air intake. We had been completely unable to find a possible source of acetylene during the previous 3 or 4 days. We don't know where the source of the detonation came from. We are assuming it was acetylene. But of course we can't substantiate it.

One thing I might add, the plant had been on stream for about three weeks following a total derime.

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Contents—

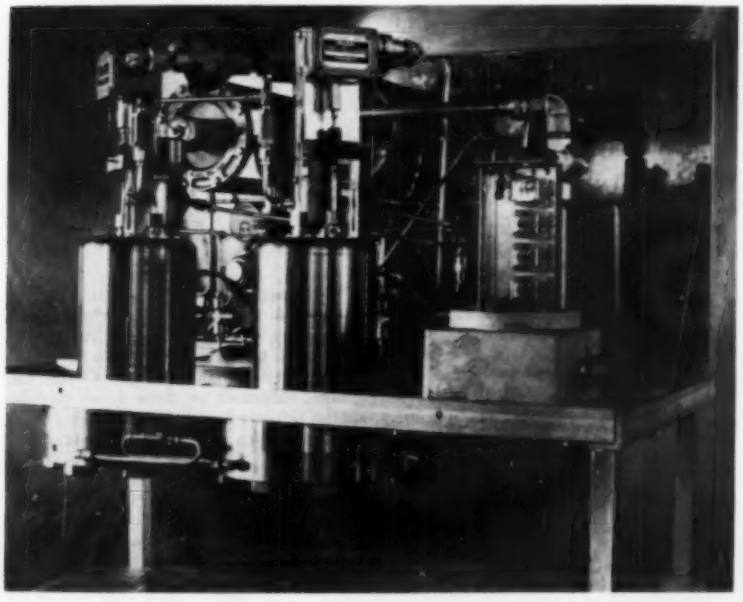
1. Unpublished discussion from St. Paul Symposium
2. Reprints of two articles "Plant Operators Report on Safety in Air and Ammonia Plants" (Parts II & III) appearing in July-August, 1959 issues of CEP.
3. Complete reprint of published symposium as appearing in May-June, 1960 CEP.

Write: **A.I.Ch.E.**
25 West 45th Street
New York 36, N. Y.

R. L. SWOPE—Southern Oxygen Co., Washington, D.C.: You mentioned that there were 75 miles of swamp. One principal product of the swamp is marsh gas, methane. Methane in our liquid oxygen, seems to stem largely from the existence of a sanitary land-fill located a half mile from our oxygen plant. When the wind is from that direction we invariably have an increase in the amount of methane in the liquid. I don't know whether methane in your case could have risen to such an extent as to be hazardous. Methane does stay behind in liquid oxygen as you boil off vapor. I don't know whether your plant involves boiling the liquid. If so, you may have a residual pool which might tend to retain the methane to a point where it might become hazardous.

WEIGERS—American Cyanamid: The point is an interesting one. However, the total hydrocarbon analyzer that was in operation during this time showed a very low reading—between 5 and 10 ppm. This is pretty much the "background noise" that we run into in our environment. I doubt that methane from the swamps was the source of our problem.

This concludes the published report on the Air-Ammonia Safety Symposium first-presented at St. Paul, with the first part appearing in the May issue of CEP. Readers interested in additional details may order reprints with supplemental material (see box). If you want to participate in the question-and-answer sessions, come to Tulsa, September 25-28, where another symposium is on the docket.



Small-scale apparatus from Mine Safety Appliances Co. for vaporizing liquid oxygen.

equipment feature

Process equipment costs in Mexico

How to figure installed costs of chemical processing equipment in Mexico. Case history data on fabrication, erection costs, and import tariff rates.

GROWTH OF MEXICAN INDUSTRY over the past ten years has promoted the establishment of local fabricating shops in all categories which manufacture various types of equipment for the process industries.

On the one hand, the Mexican authorities grant special duty and tax exemptions for industries considered basic to the development of the country; this keeps within reasonable limits the duties which must be paid for importation of special process equipment. On the other hand, establishment of new local manufacturing facilities tends to eliminate importation of equipment which can be made locally. This restriction of imports for the protection of local manufacturers usually takes the form of an increase in duty but, in some cases, may involve an outright prohibition of the importation of certain equipment.

In general, special equipment such as large boilers, steam turbines, high-pressure compressors, and specialized machinery such as paper-making machines, large hydraulic presses, etc., can be imported into Mexico at duties averaging 6% of prime costs. Freight for this type of equipment is also of minor importance, generally in the range of 2-4%. Installation costs will vary with the particular nature of the equipment over a range of 4 to 15%.

Between the two extremes, there are many "border-line" cases, where importation will in certain cases be accepted by the authorities and in other cases turned down. Equipment falling into this classification can play havoc with construction schedules by overoptimistic assessment of import possibilities. Table 1 shows additional costs to be expected for various types of equipment installed in Mexico.

Piping installations

Local materials for chemical plant piping installations in Mexico are still limited and, as a result, a good percentage of such materials must still be imported.

Carbon steel pipe, conforming in general to ASTM Standard A-53, is being made in Mexico in both butt-welded and seamless types, in practically all sizes.

Piping of special material, such as stainless steel, glass, PVC, Saran-lined, Karbate, etc., still has to be imported. Fittings for carbon steel pipe, both forged and welding, are imported.

The local market supplies only a

continued on page 80

Table 1. Cost of equipment

(100%=Prime Cost in U. S. domestic market)

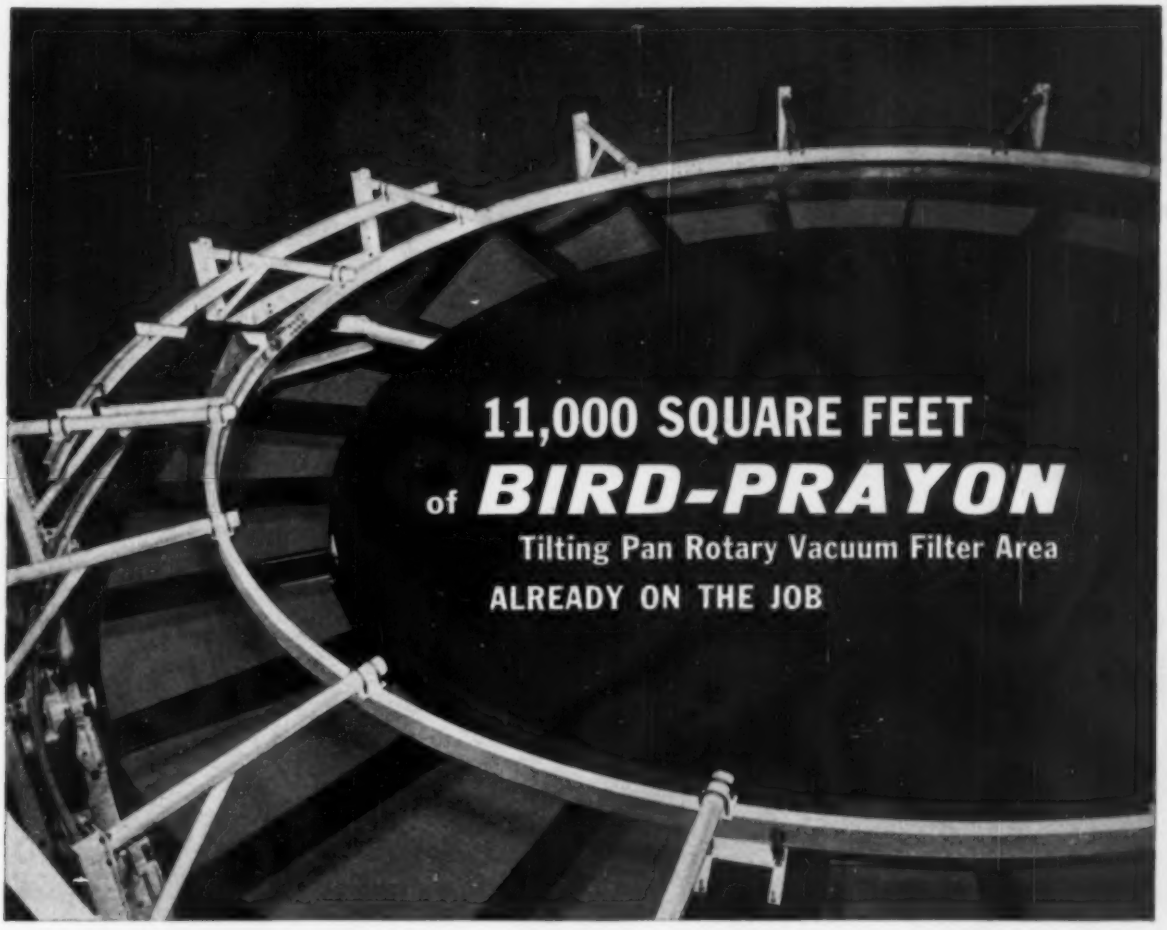
DESCRIPTION	SOURCE	DUTY AND FREIGHT OR LOCAL MFR. MARKUP	INSTALLATION	NOTES
Belt, screw conveyors and bucket elevators	M	15 – 20%	12 – 15%	*1*
Pumps–IBBM or AI	M	0 – 30%	12 – 15%	–
Pumps–special alloy	F	25%	8 – 12%	*2*
Heat exchangers	M or F	15 – 25%	8 – 12%	*3*
Process kettles–MS	M	10 – 20%	10 – 15%	–
Process kettles–alloy	M or F	10 – 50%	6 – 10%	*4*
Process kettles–glass lined	F	50 – 60%	5 – 8%	*5*
Dryers, kilns and coolers	M or F	10 – 20%	10 – 12%	*6*
Agitators	F	20%	10 – 15%	–
Rotary vacuum filters	F	12%	15%	–
Pressure vessels	M	50%	10 – 12%	*7*
Screens	F	20 – 30%	10 – 15%	–
Boilers, package	M or F	15 – 20%	12 – 15%	–
Boilers	F	10 – 15%	15 – 20%	–
Water softeners	F (M)	15 – 20%	15 – 20%	*8*
Evaporators	F	15%	15%	–
Evaporators	M	0%	15%	–
Large tankage, M.S., generally field fabricated	M	Total Cost: $5,500.00–$6,000.00 Mex. Cy. per metric ton installed.		

NOTES:

M = Mexican manufacture.
F = Foreign manufacture.

1 Bearings and chain imported.
2 Importation of this type of pump is becoming more restricted.
3 There are two local manufacturers at present going into production. Consequently the importation of heat exchangers will become more restricted.
4 Process vessels made of stainless steel, Monel, or special alloy, can be fabricated in Mexico through importation of raw materials (plate). Duties for imported vessels vary over a wide range, inasmuch as there is no specific tariff under which this equipment can be imported. Average cost of a type 304 stainless steel vessel manufactured in Mexico will be $50.00 Mex. Cy. per kilogram.
5 Although glass-lined vessels are not fabricated in Mexico, these have been subject to a very high tariff during the last year.
6 This type of equipment is manufactured locally in the smaller sizes.
7 Pressure vessels are being manufactured in Mexico by three fabricators. The markup shown corresponds to locally fabricated vessels.
8 Ion exchange units are partially fabricated and assembled locally, importing the resins and hardware. Large softeners are also partially fabricated in Mexico, importing all mechanisms, feeding devices, and the like.

**Excerpted from an article titled, "Actual Construction Costs from the Mexican Point of View," by R. Pardo G., E. Davalos O., M. Girault, Jr., C. Aedo G., Bufete Industrial, Mexico, D.F.*



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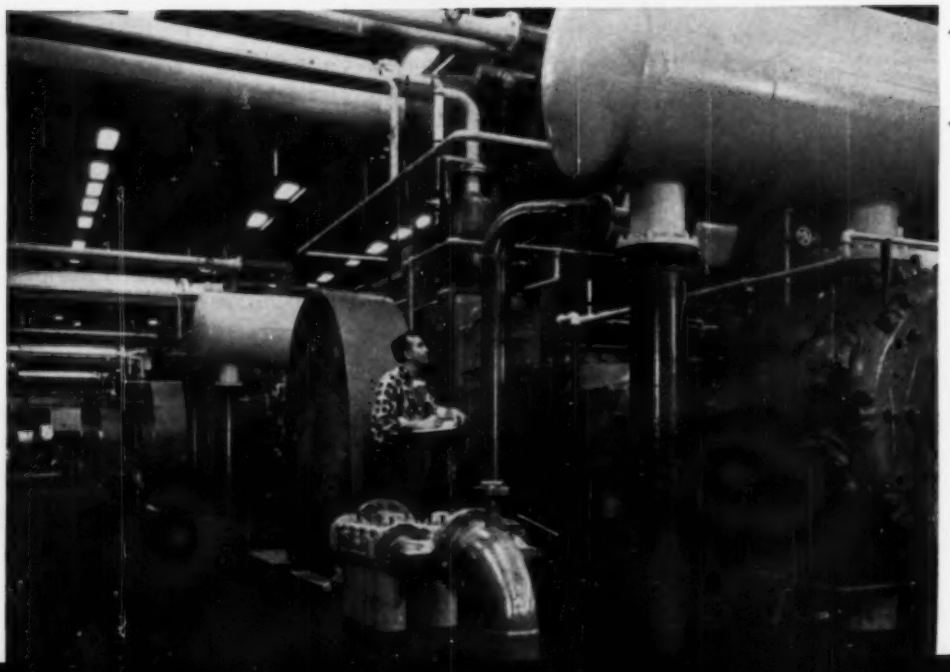
Cooper-Bessemer compressor shown is one of two units for compression of synthesis gas.



View showing the four Cooper-Bessemer compressors. Unit in foreground is for "mixed gases" (air, nitrogen and methane).

Henry LaRue, *Ammonia Area Superintendent, Spencer Chemical Company, Vicksburg, Mississippi explains...*

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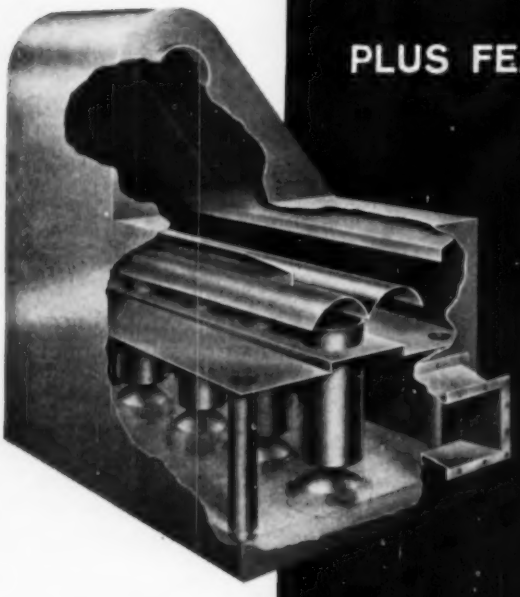

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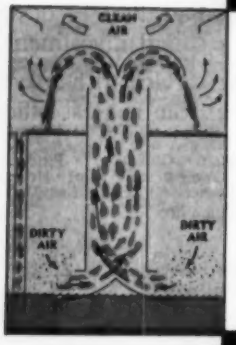

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Equipment costs

from page 76

few types of bronze valves in the smaller sizes. Iron, steel, stainless, and special diaphragm valves are all imported, mainly from the U.S.

In the major cities, however, there exist local dealers, generally associated with U.S. piping material fabricators, who carry a certain number of stock items, chiefly in mild steel. Such material has already paid all necessary duties and the prices include the dealer's markup. Table 2 gives an idea of the various markups to be expected.

Table 2. Piping materials cost

	Description	% Markup on U.S. Domestic Prices
I.	*Steel*	
	a) Pipe	50
	b) Welding Fittings	60
	c) Forged Fittings	40
	d) M. I. Fittings	40
	e) Valves—Steel	25
	Iron	25
	Bronze	90
	Special Alloy	25
II.	*Stainless Steel*—All materials	30
III.	*Glass*—All materials	40

Pipe supports are generally field fabricated following types common in U.S. practice. Only very special supports, such as spring types for steam mains, are imported.

Skilled installation labor is relatively inexpensive, especially compared to U.S. standards. However, cost of construction equipment is higher than in the U.S. Therefore, it is not possible to compare Mexican and U.S. installation costs by a simple factoring of the wage rates. A study of eight case histories covering chemical plant piping installations over the past five years, corrected for price increases over the same period, gave the averages shown in Table 3.

Table 3. Piping installation cost
(*% Markup on U.S. Domestic Prices*).

Material	Valves	Pipe and Fittings	Supports	Installation Labor
Steel	30	30	5	35
Stainless Steel	23	62	1	14
Glass	10	53	2	35

NOTE: Averages of eight case histories.

Instrumentation

All types of instruments, from manometers up to the most complicated type of control instruments, are being imported, mainly from U.S.

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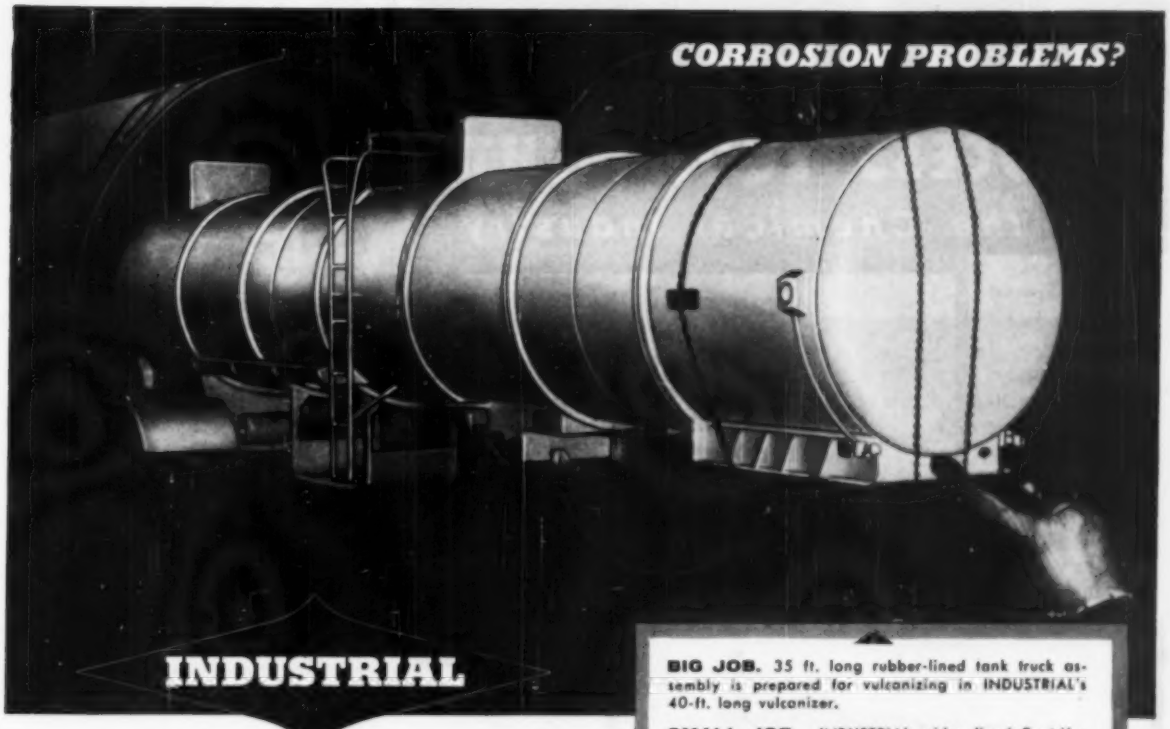

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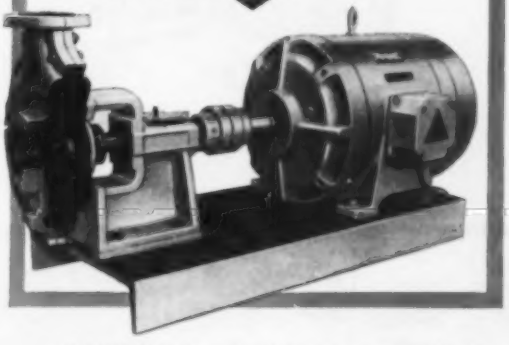

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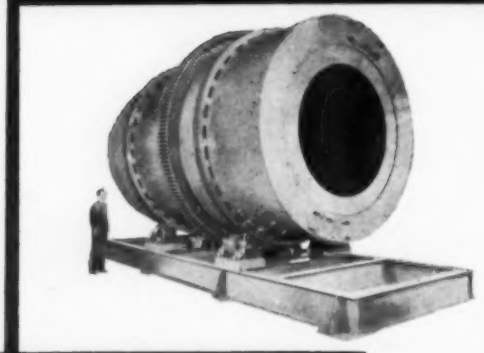

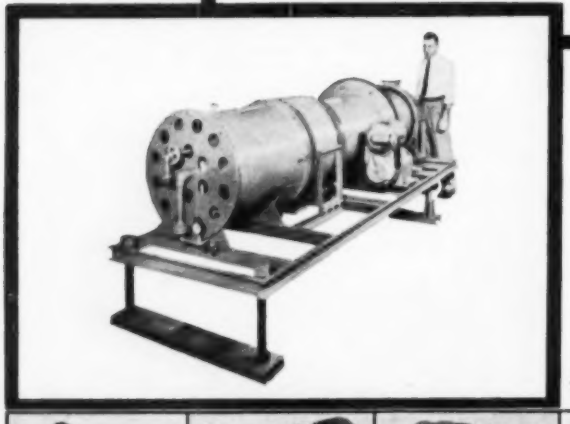

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2639 BOSTON STREET, BALTIMORE 24, MD.

For more information, turn to Data Service card, circle No. 42

Equipment costs

from page 80

sources. Additional cost for bringing these instruments into Mexico can be estimated at 15% of their prime cost. Installation cost will vary from 15% for the simple types to 25% for the more complicated ones.

Insulation

There are available in Mexico locally manufactured insulation materials of the glass fiber type, as well as of the 85% magnesia type with a K factor of 0.40, weighing approximately 12 lb./cu. ft. Special cement for weather proofing and various types of vapor-barrier adhesives are readily available from import sources.

Glass fiber insulation for processing vessels, 1½ in. thick, held in place by wire mesh and finished with smooth-trowelled cement and water sealer, will cost approximately $180 per square meter installed. Such insulation would be suitable for operating temperatures of 400°F. Cost of 85% magnesia insulation for similar operating conditions would run about 10% lower in price.

Insulation proper for a 5°F operating temperature, of fiber glass 1½ in. thick, complete with vapor barrier of aluminum-base Kraft paper completely sealed with adhesive, finished with smooth-trowelled cement and weather-proof material, will run approximately $220 per square meter installed.

For pipe lines, preformed insulation is available in Mexico in either of the two basic types mentioned above. Average installed cost per linear yard, 1 in. thick, with weather-proof finish, for operating temperatures of 400°F would be:

Pipe Diameter	Glass Fiber	85% Magnesia
1 in.	$46.00	$35.30
2 in.	56.50	43.00
3 in.	68.50	52.00
4 in.	80.50	64.20

For 5°F insulation, cost per linear yard of fiber glass insulation, duly weather-proofed, 1½ in. thick, would be:

Pipe Diameter	Installed Cost
1 in.	$70.00
2 in.	106.00
3 in.	122.00
4 in.	140.00

Of the above costs, installation

continued on page 84

MATHESON

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Compressed gases can be handled safely and without difficulty if proper procedures are followed. This new chart outlines the correct handling procedures for every compressed gas available in cylinders for laboratory use. The chart was developed by Matheson's Technical Department. Step by step illustrations show approved methods for Receiving Cylinders, Moving, Handling Empty Cylinders, and Using the Gases. The 14" x 21" chart was designed for wall mounting in the plant, laboratory, or wherever gases are received, stored or used.

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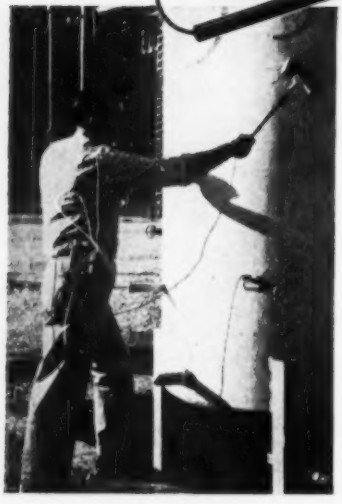
For more information, turn to Data Service card, circle No. 66

Maintain Coating Application Standards

INSPECT WITH A TR HOLIDAY DETECTOR!



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A tiny pinhole "holiday" in the protective coating allows a foothold for corrosion to undercut the coating. Progressive corrosion follows with peeling, scaling and ultimate failure.

You can't see these deadly "holidays," they become visible only when it's too late.

The M-1 TR Holiday Detector accurately and quickly finds pinholes and bare spots in thin film protective coatings. In operation an electrode is passed over the surface. On encountering a void or bare spot, a small current flows and a bell rings. Maximum applied voltage is 67½ V.

Different models of TR Holiday Detectors are available for pipe or flat surfaces, damp or dry surfaces and for portable or production line operation.

Engineering Note:
To insure a perfect application, your specifications should include TR holiday detector inspection. Write for specification guide.

Write today for technical data and bulletin.

Quality Control for Coating Application

TR TINKER & RASOR

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For more information, turn to Data Service card, circle No. 39

Equipment costs

from page 82

labor represents approximately 30%, the balance being cost of materials.

Special linings

Hard rubber linings for tanks and process vessels is done by three major Mexican firms. The linings are in every way comparable to those obtained from foreign sources.

Application cost, including preparation of the vessel walls, can be summarized as follows:

Lining thickness	Cost per square meter
3/16 in.	$385.00
¼ in.	430.00

Lead lining of process vessels is also carried out by various local fabricators. Total installed cost of lining will average $10.00 per kilogram of lead.

A consulting service in the high pressure field was formed recently by a group of scientists and engineers, all with experience in high pressure techniques. The group, known as High Pressure Associates, was formed as the result of a two-day meeting at Erie, Pa., held under the auspices of Autoclave Engineers, Inc. Purpose: to facilitate bringing together those with experience in the rapidly growing field of high pressure applications, and those who seek help on problems. They will offer consulting service in the general high pressure field to any organization or individual. Other purpose is the initiation of standards for high pressure work, and preparation of a handbook of safety measures. Chairman of the group is B. F. Dodge, Yale University.

Construction of a $3.6 million propane deasphalter begins at Sun Oil's refinery in Toledo, Ohio, in August. The 10,500 barrels a day facility will be one of the largest propane deasphalters in the United States when completed in 1961.

Regulations for the Admission of Student, Graduate, and Corporate Members and for the Examination of the Institution. This pamphlet contains recent changes in requirements for membership in the Institution of Chemical Engineers. Revisions made by the British organization are mostly in defining qualifications which exempt from the Institution Examination.

For more information, circle No. 122

ECO ENGINEERING NEWS

the big name in small pumps for the process industries

Pumping Problems Solved with Eco

(Names of users, where not mentioned, will be supplied on request)

Methanesulfonyl Chloride:

Highly reactive, methanesulfonyl chloride is being pumped continuously, from 8 hours to 24 hours per day with complete satisfaction by Eco GEARCHEM Pumps made of zirconium and du Pont Teflon. Leakage of this lachrymatory liquid is positively controlled.

This installation replaced another make pump which cost over $1000.00 and which required another $1000.00 per year to keep in repair.

Lacquer Ink Services:

Reynolds Metals Company have used Eco BRONZECHEM Pumps for lacquer ink services for the past five years and continue to order.

These bronze body pumps with Teflon Impellers, bearings and packing are of rotary, positive displacement design providing linear, *non-foaming* flow ideal for this service. They are periodically flushed to prevent hardened lacquer film build-up within the pump during shutdown cycles.

Mercury:

Mercury is a problem fluid to pump. It is bone dry—having no lubricating qualities at all. It is 14 times heavier than water. And it is a fugitive element extremely hard to contain in any conventionally packed stuffing box.

The exclusive capabilities of Eco GEARCHEM Pumps to handle this medium with flows in the gallon range and providing accurate metering to the requirements of the chemical, electronic, instrument and other industries, have been responsible for many recent installations.

These Eco pumps in service have a maximum rate of 5 gpm at 100 psi with flooded suction. Some are being driven by 1200 rpm direct connected motors and others are belt driven. After several months, without need for service, the Eco lantern ring stuffing box with Teflon packing and special sealing grease, still provides positive leakless operation.

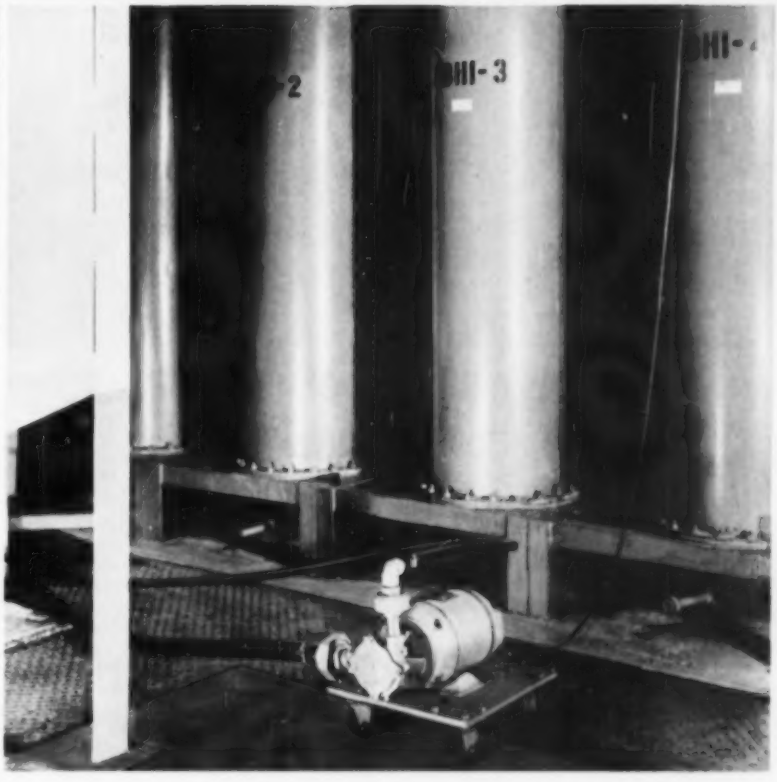
302°F Sulphuric Acid:

Because of the increased corrosive effect of sulphuric acid at advanced temperatures, an Eco GEARCHEM Pump made of Hastelloy* C with Hastelloy C shafts and gears, ceramic wear plates, carbon sleeve bearings and Teflon packing was selected for this service.

Eco's wide choice of metals from the stainless steels to zirconium and titanium provides the answer to all corrosives, concentrations and temperatures.

(*continued on next page*)

*Union Carbide Trademark.



Pumping Acid Solutions of Rare Earths in Ion Exchange Installations

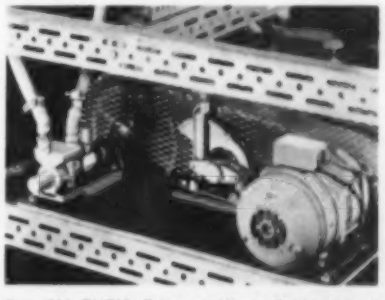
At Lindsay Chemical Division of American Potash & Chemical Corp., Eco CENTRI-CHEM Centrifugal Pumps are literally supplying "Taxi Service" for acid solutions of Rare Earths and sequestering agents.

Mounted on castered dollies, as illustrated above, and coupled to hoses or flexible pipes, these compact pumps are moved from system to system as the cycle of operation progresses, supplying the flexibility needed for solution transfer in these ion exchange installations. In some cases, it is not unusual to have pumps operate continuously for twenty-four hours or longer.

The CENTRI-CHEM Pumps of Carpenter 20 stainless steel are standard-equipped with Eco mechanical seals of Teflon-ceramic design. They have proved dependable and have occasioned very little down time over a period of more than 4 years.

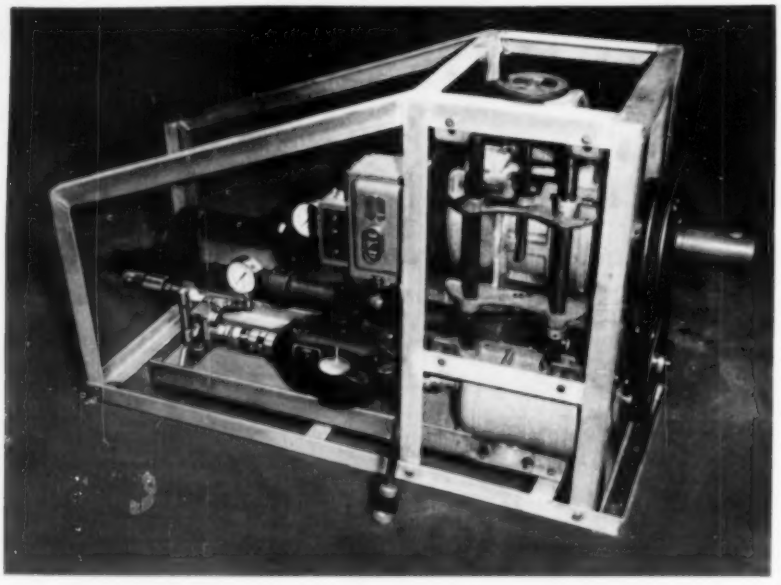
Also at Lindsay are Eco ALL-CHEM positive displacement rotary pumps equipped with fluid Teflon seals. These pumps, utilized in solvent extraction, transfer acid solutions of Rare Earths and organic solvents over a wide delivery range from 0.1 to 20 gpm. These pumps are coupled to variable speed drives for varying delivery rates.

These Eco ALL-CHEM Pumps also have proved dependable for this service.



Eco ALL-CHEM Pump, with variable speed drive, serving solvent extraction installation at Lindsay Chemical Div., American Potash and Chemical Corp.

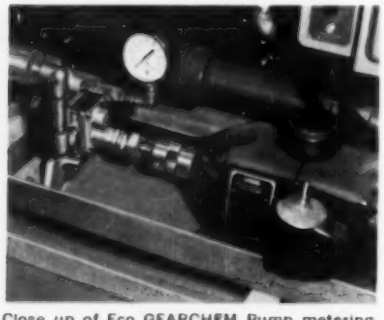
ECO ENGINEERING COMPANY · 12 New York Avenue · NEWARK 1, N.J.



Triggering "Gel" of Chemical Grout in Soil Stabilization

Thomas Adair Contracting Corporation, Edison, New Jersey, manufactures equipment for injecting chemical grout to solidify weak, granular soils during tunneling and construction excavating, as well as to seal off flows of underground water into oil wells, drill holes, basements, tunnels, mine shafts, coffer dams, sewer pipe joints, caissons, etc. Of special interest is its use to seal underground curtain walls in and around dams or dikes.

The equipment comprises two positive displacement pumps—one for handling the water-thin chemical grout, which easily penetrates the soil to be stabilized, and the other, an Eco GEARCHEM Pump with Vickers variable speed drive which permits accurate proportioning of the amount of ammonium persulphate catalyst, introduced at the point of injection, to vary the gel time required, which may range from a few seconds to several hours.



Close up of Eco GEARCHEM Pump metering catalyst in chemical grout injection system.

This equipment, now generally available to the construction contracting industry, was designed by engineers who pioneered chemical grouting and have had many years of experience in its application on all types of soil stabilization problems from coast to coast.

Their selection of Eco GEARCHEM Pumps in 316 stainless steel with Teflon gears, bearings and packing as standard equipment for these units was made after careful investigation of all small chemical pumps available for the purpose.

The GEARCHEM Pump's positive corrosion resistance; its unmatched dependability, day in and day out in hard service in the field; its accurate metering ability; and the fact that it is a standard stock pump, easily and quickly available anywhere and with complete interchangeability of precision parts for field maintenance, offered outstanding advantages which no other small chemical pump could provide.

ECO Products for Handling Corrosive and Hazardous Processing Fluids

ALL-CHEM® Rotary Pumps
MINILAB® Rotary Pumps
GEARCHEM® Gear Pumps
CENTRI-CHEM® Centrifugal Pumps
PUMPMOBILE® Portable Pumping Units
GEAR-VAC® Valves
CHEMICAL DISPENSING VALVES
Factory Mutual Approved

Ask for literature on any or all of these ECO Products

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Pumping Problems *(continued)*

Methylene Chloride:

Dow Chemical keeps reordering Eco CENTRI-CHEM Carpenter 20 stainless steel pumps for methylene chloride service.

Since this is a nasty solvent, leakage of which would not only be objectionable but hazardous as well, it is undoubtedly the superior dependability of Eco's Teflon-Ceramic mechanical seal which has influenced Dow to pass over all the other centrifugal pumps on the market today and continue to specify the Eco CENTRI-CHEM for methylene chloride.

Nitric Acid Transfer:

Eco CENTRI-CHEM Carpenter 20 stainless steel pumps are used by Wyandotte Chemicals Corp.

Sorbitol: (Reg. T.M. Atlas Powder Company) with viscosity of 750 SSU at 100°F is pumped at 50 psi with Eco GEARCHEM Pump in 316 stainless steel construction.

Monochloracetic Acid: an exceedingly hazardous material, is pumped with an Eco GEARCHEM in Hastelloy C, with Teflon components and floating wear plates.

Special Detergent: a compound of dodecylbenzene sulfonic acid, sulphuric acid, sodium hydroxide, lauryl diethanolamine, nonylphenol 12-ethylene oxide, hexylene glycol, isopropanol and odorant with water—is pumped with Eco GEARCHEM Pump of Carpenter 20 stainless steel with Hastelloy gears. Temperature of media is about 100°F with viscosities to 3000 SSU.

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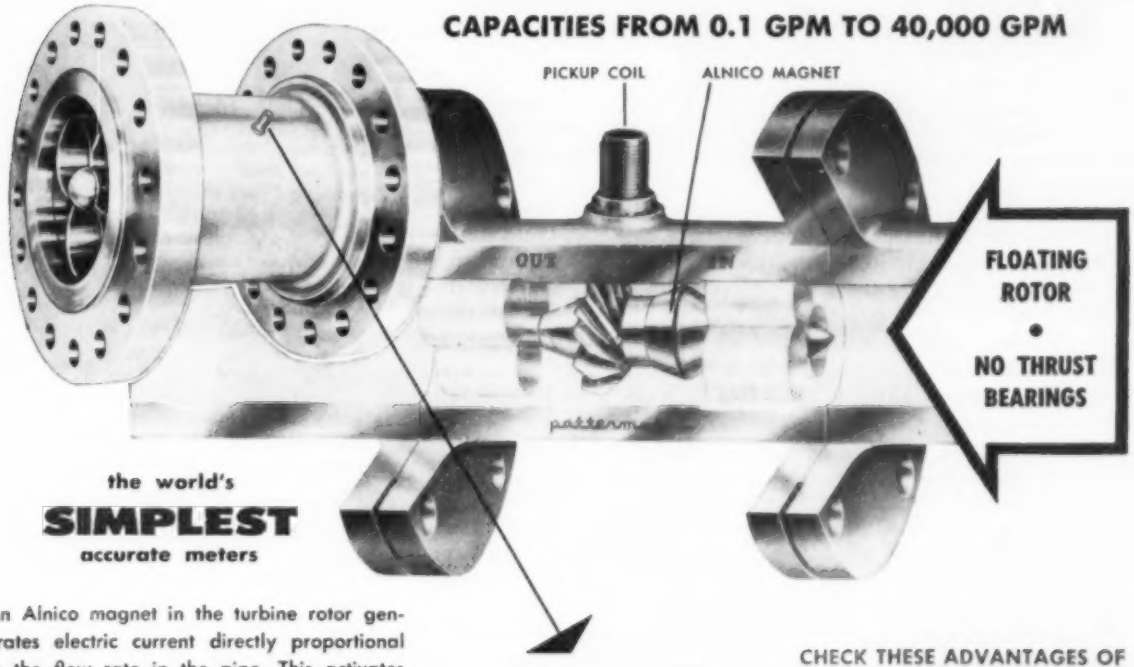
TURBINE TYPE METERS

CAPACITIES FROM 0.1 GPM TO 40,000 GPM



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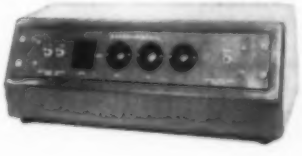
PROVIDES BASIC INSTRUMENTATION FOR ANY AUTOMATION SYSTEM

Operating by gravity or pump pressure, Pottermeters are available in all pipe sizes. Electronic totalizers, recorders or controllers meet any need for automated liquid process or transfer operations. Potter-Bowser sales engineers in principal cities confer promptly with systems or plant engineers to detail availabilities and application data.

READOUT and CONTROL equipment as needed



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- ✓ ELECTRONIC READOUT EQUIPMENT, To specifications
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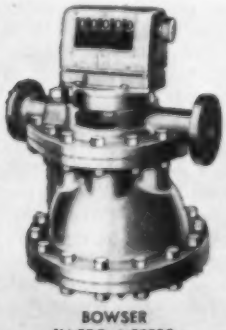
- ✓ ACCURACY, Unexcelled

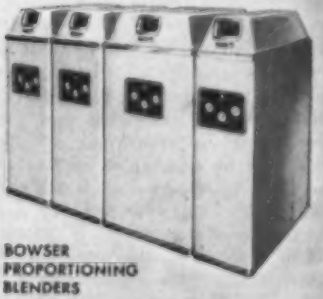


BOWSER XACTO METERS

BOWSER XACTO METERS AND PROPORTIONERS
positive-displacement piston type

Wherever mechanically driven readout and control equipment is indicated, and where positive-displacement metering is needed or costs less, Bowser Xacto Meters (leading all others in industry) are unexcelled for dependability and accuracy.
Capacities: 6 GPH to 250 GPM

Xacto Meter equipped proportioners are used to blend two or more liquids in continuous flow at accuracies to ½ of 1 percent. First in lube oil blending, Bowser proportioners also handle most other liquids used by process industries.



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Potter-Bowser Division* BOWSER, INC. *Fort Wayne, Indiana

For more information, turn to Data Service card, circle No. 34

CEP

COMPUTER PROGRAM abstracts

The Machine Computation Committee of the A.I.Ch.E. is interested in receiving program abstracts. Once again the Committee wishes to emphasize the three rules for participation in the interchange program:

1) Abstracts submitted for publication must follow the form published in *CEP* (January 1959) and in the *Guide*. The submitter of the abstract agrees to make available for publication the program manual prepared along the lines suggested in the *Guide* should sufficient interest develop.

2) Abstracts must be sent to the Machine Computation Committee c/o A.I.Ch.E.

3) All questions relating to published abstracts must be sent to the Committee c/o A.I.Ch.E. in New York.

The decision on whether to have a detailed program manual prepared and published depends on the response to the corresponding abstract. Where sufficient interest has not been shown during the 1 year period after publication of a given abstract, the submitter will be released from his commitment to prepare a manual. An announcement to this effect will subsequently appear in *CEP*.

Since the first abstracts were published 2 years ago, the Committee will shortly start determining whether any manuals will definitely not be published. Consequently, those who are interested in having manuals prepared on some of these programs, but have not yet notified the Committee, should do so promptly.

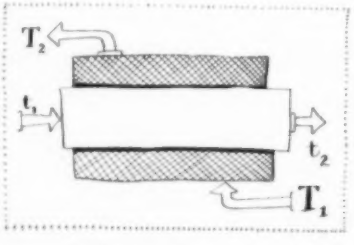
Liquid-liquid heat exchanger design (052)

*B. G. Price and D. L. Bissell**
Celanese Chemical Co.
Data Processing System
P. O. Box 561
Corpus Christi, Texas

Description: Based on the user's estimate of the overall heat transfer coefficient the equivalent required area is approximated by the program and the smallest four-tube-pass exchanger meeting these area requirements is picked from a table. The dimensions of this exchanger are then used to calculate pressure drops, film coefficients, etc., and if the exchanger selected is not over or undersized insofar as duty, velocities, and pressure drops are concerned, it is reported as an acceptable unit. If, on the other hand, any limit is exceeded, another exchanger is selected from the table and the process is repeated. When necessary, the program will automatically place exchangers in series and/or parallel. Two-pass and single-pass units are similarly tested.

The program will, if so instructed by the user, limit its investigation to exchangers of one tube length. However, unless otherwise instructed it will investigate each of several tube lengths obtained by decreasing the maximum tube length by any desired fixed increment.

Baffle cut and spacing are adjusted



automatically to obtain the highest shellside velocity compatible with the velocity and pressure drop limitations. Laminar flow of either liquid is not permitted.

Computer: Burroughs 205, paper tape and numeric card (PCC-500) input-output.

Program language: Burroughs 205 machine code.

Running time: From 40 minutes for simplest case (outlet temperatures specified and one tube length only) to five hours for most involved problem to date.

Availability: A manual will be prepared if sufficient interest in this program develops.

* *Mr. Bissell is presently with Daystrom, Inc.*

Automatic computational procedure for the thermodynamic correlation and prediction of vapor-liquid equilibria (055)

Jerry A. Acciarri and Robert F. Sweeny, (1) Continental Oil Company, Ponca City, Oklahoma, and (2) Applied Science Laboratories, Inc., State College, Pennsylvania

Description: The program calculates the vapor-liquid compositions from the experimental relationship between temperature and liquid composition. The method used is sometimes referred to as the trial and error prediction method (Arthur Rose, et. al., *Ind. Eng. Chem., 45,* 1568 (1953)), and will give values based on both the Van Laar and Margules integrated forms of the Gibbs-Duhem equation. Used as a test of thermodynamic consistency of experimental data, the vapor-liquid compositions are calculated from experimental values of temperature and liquid at equilibrium and compared to actual vapor-liquid compositions. Or, the method may be used to obtain the vapor-liquid data when only temperature-liquid composition data are measured.

Computer: IBM 650, Basic.

Program language: Fixed decimal machine language.

Running time: About three minutes for complete prediction or correlation of a binary system at nine compositions. Sometimes up to ten minutes are required.

Availability: A program manual can be made available for publication should sufficient interest develop.

continued on page 90

All parts which control action inside are located outside—no danger of contamination, corrosion or erosion to pneumatic or hydraulic equipment, etc.

Process piping extends through vessel wall—door opens without piping disconnection.

Simple external adjustments of knife, cake, etc.

Finger-tip double-acting door, automatic positioning; effective pressure closure; positive locking.

Built to handle full 150 HP, in high capacity, day-in, day-out operation.

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(even on slow draining, compressible fine solids)

Full hydraulic rotary-action knife unloads 300-400 lbs. load in 2-8 seconds with full 150 HP.

Six-section knife blade, easily adjustable and replaceable by identical sections at low cost.

Full-flow, air operated feed system delivers slurry uniformly across full width of basket.

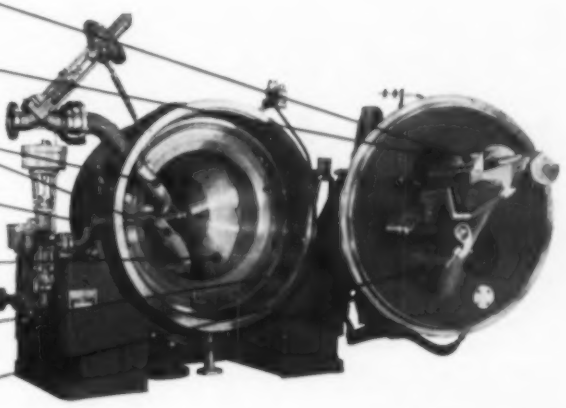
Multiple rinsing system; disconnect rinse tube internally without disturbing external piping.

Large screen area; thin even layer of solids under high centrifugal force, gives up liquid quickly without compaction.

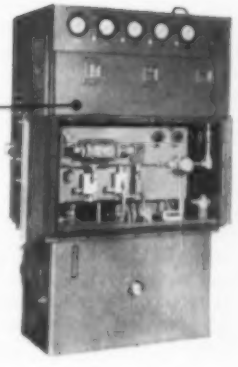
Teflon "splash seal" (hidden) prevents flow-back of crystals into mother liquor.

Smooth action cake leveler balances load; easily adjustable to control cake thickness.

Precision drive and bearing assembly; sealed housing with pressure lubrication system from control cabinet.



Continuous cyclic operation at full speed, with fully automatic control. Any part of the cycle may be adjusted while the machine is in operation.



Over a dozen C-41 Super-D-Hydrators already are proving themselves profitable workhorses in the deliquefication of such sensitive materials as the polyolefins and other hydrocarbons where high purity and extreme dryness are the byword.

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For more information, turn to Data Service card, circle No. 12

top entering propeller agitators low cost

Chemineer, Inc. believes the way to provide users with top entering agitators of low first and ultimate cost—is to make them simple. This is deliberate design simplification, with emphasis on ruggedness. Such practices keep our cost—and yours—within reason. Illustration; all Chemineer top entering agitators use standard NEMA "C" flange motors through 3 hp. You can get a replacement immediately from local sources.

Gear drive units have heat treated alloy steel helical gears operating in an oil bath. Stuffing box is easily accessible. Chemineer designs keep the maintenance man away to keep the agitator on the job. Please request Bulletin 220 from Chemineer, Inc., 1044 E. First Street, Dayton 2, Ohio.

CHEMINEER®
FLUID AGITATION ENGINEERS

For more information, circle No. 68

Computer abstracts

from page 88

Design of isothermal batch chemical reactors (058)

Kansas State University
Manhattan, Kansas
Programmed by Bih-Jing Jeng and Liang-tseng Fan
Department of Chemical Engineering

Description: This computer program is for the design of uniformly stirred batch chemical reactors operated isothermally and under steady state. This program contains four separate sub-programs, (A), (B), (C), and (D).

(A). This subprogram calculates the final concentration of reactant or degree of conversion when other operating conditions such as initial concentration, space velocity and number of reactors are given.

(B). This subprogram computes the number of reactors required to accomplish the desired degree of conversion under given space velocity and other operating conditions.

(C). This subgroup yields the space velocity needed to attain the desired degree of conversion.

(D). This subgroup estimates the initial concentration to obtain the desired final concentration of the reactant or the desired conversion under various operating conditions.

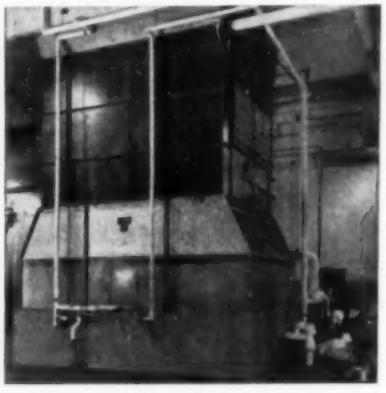
Computer: Basic IBM 650 with alphabetic attachment and 2,000 word storage, with floating point and index registers.

Program Language: Program prepared with SOAP routine. Standard 80/80 Input-Output panel is used for the computation.

Computing Time: Computing time depends on order of reactions, operating conditions and number of reac-

continued on page 92

WHEREVER YOU NEED TO COOL A FLUID... and have a problem of water supply or disposal... use NIAGARA "AERO" HEAT EXCHANGER



► Evaporating a very small amount of water in an air stream you can cool liquids, gases or vapors with atmospheric air, removing heat at the rate of input, controlling temperature precisely. Save 95% of the cost of cooling water; save piping, pumping and power. You quickly recover your equipment cost.

You can cool and hold accurately the temperature of all fluids, condense vapors, cool water, oils, solutions, intermediates, coolants for mechanical, electrical or thermal processes. You have a closed system free from dirt. You have solved all problems of water availability, quality or disposal, maintenance expense is low.

You may apply this to solvent recovery, vacuum systems controlling reactions, condensing distillates, cooling reflux products.

For more information, write for Bulletins 120, 124, 135. Address Dept.

NIAGARA BLOWER COMPANY
Dept. EP-6, 405 Lexington Ave., New York 17, N. Y.
Niagara District Engineers in Principal Cities of U. S. and Canada

For more information, turn to Data Service card, circle No. 36

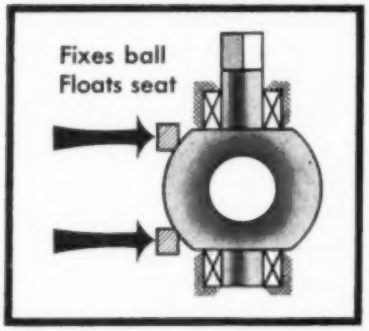
Can A Ball Valve Operate, Cycle After Cycle, With No Maintenance At All?

Read this remarkable answer, and discover an amazing engineering feat.

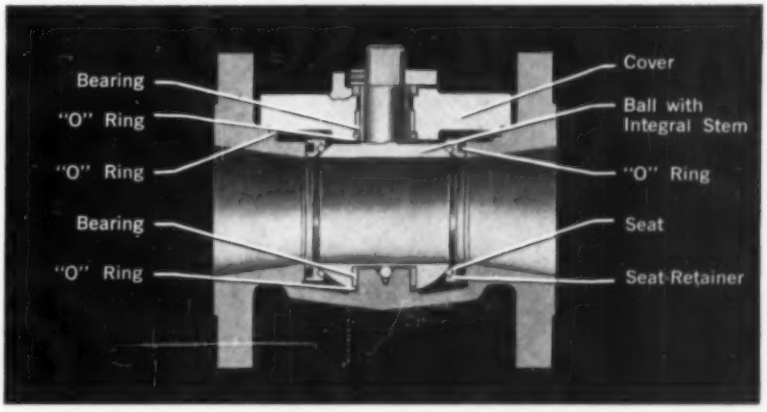
As most engineers know, ball valves offer a number of distinct advantages over all other types of valves . . . 90° on-off, minimum pressure drop, positive on-off indication, no lubrication, and compactness. In common with other valves, however, the design was insufficient to overcome the problem of continual maintenance.

Four years ago, this problem was faced by Hydromatics, Inc. in the valves that they produced for use in missiles, aircraft and ground support systems. Then, as today, all other ball valves were built with a ball that floated in its socket, and sealed by being forced against its seat by the pressure in the line. This caused seat distortion which made early replacement necessary.

Hydromatics tried a different approach. Rather than use the traditional floating ball, their engineers fixed the ball in bearings.



In the bearing-fixed **FLO•BALL** valve all pressure forces exerted on the ball are transmitted to low-friction bearings, thus eliminating down-stream seat distortion due to ball load. The pressure balanced seat, with its teflon sealing surface, is continually self-adjusted by the O-ring in the seat retainer.



This O-ring acts as a self-energizing force that keeps the teflon seat always in contact with the ball. This insures positive sealing without seat distortion, and minimizes seat-resisting frictional forces. The combination of these low frictional forces results in low operating torque and extremely long seat life.

The bearing-fixed **FLO•BALL** valve proved itself immediately. Hundreds of missile and spacecraft systems, previously impossible, were made possible with these valves. The X-15, America's first manned space vehicle, for instance, has a Hydromatics **FLO•BALL** valve at its heart. Since its inception, the **FLO•BALL** has been used in more varied applications than all other ball valves combined.

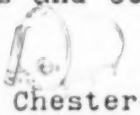
Now, after the toughest application testing in history, bearing-fixed **FLO•BALL** valves are being mass produced for industry. They are available for off-the-shelf delivery to standard ASA dimensions in semi-steel, carbon steel, stainless steel, and aluminum. They operate at pressures to 600 psi, temperatures to 400°F and hold vacuum to 10^{-6} mm. of Hg!

The bearing-fixed **FLO•BALL** offers extra ball valve advantages. Top loading for easy access without removing the valve from the line, plus three features that are absolutely unique! Self-adjusting seats which automatically compensate for wear, proportional sealing force which automatically increases with line pressure, and the lowest torque, by far, of any valve. These combine to make the **FLO•BALL** valve virtually maintenance-free!

How long does it last without maintenance? Frankly, we don't know, since the first valves we ever built are still going strong and outlasting other valve types by more than 10-to-1. But don't take our word for it. See for yourself. Call, write or TWX for further information.

Hydromatics, Inc.
Livingston, New Jersey
Telephone: WYman 2-4900
TWX-LIVINGSTON NJ 120

For more information, turn to Data Service card, circle No. 9

Chester-Jensen is the first name in high-efficiency stainless steel apparatus for heating, cooling, regenerating any liquid that pours - with a single unit, the Plate Heat Exchanger, or with a combination such as the Shell-and-Tube Heater and the "Beaudelot" Cooler as a specific liquid or process may require. Vats for batch processing; Internal Tube Heaters and Coolers, and Storage Tanks  are also included in the Chester-Jensen line.

Chester-Jensen Equipment Is Built Entirely In U.S.A.

CHESTER-JENSEN COMPANY

347 Tilghman St. (Dept. S) CHESTER, PA. INCORPORATED

Specialists in Stainless Steel Industrial and Food Equipment

For more information, turn to Data Service card, circle No. 51

Computer Abstracts

from page 90

tors. It ranges from a few seconds to a few minutes.

Comments: The programs work within an accuracy of seven decimal points for (A), (B), and (D), and four decimal points for (C).

Availability: A program manual can be made available for publication should sufficient interest develop.

Machine Computation Committee
A.I.Ch.E.
25 West 45th Street
New York 36, New York

I am interested in computer program manuals corresponding to the following abstracts:

- ☐ **Liquid-liquid heat exchanger design (052)**
- ☐ **Automatic computational procedure for the thermodynamic correlation and prediction of vapor-liquid equilibria (055)**
- ☐ **Design of isothermal batch chemical reactors (058)**

Check one of the boxes below:

- ☐ **I plan to purchase copies of the manuals checked after they are published.**
- ☐ **I wish to place an order for one copy of each manual checked.**
- ☐ **I wish to place a blanket order for one copy of each manual published by the A.I.Ch.E.**

I wish to place an order for one copy of the manuals now available.

- ☐ **No. 1. Line Sizing (Abstract 006)**
- ☐ **No. 2. Liquid-Liquid Heat Exchanger Design (Abstract 018)**

NAME.....

COMPANY.....

ADDRESS.....

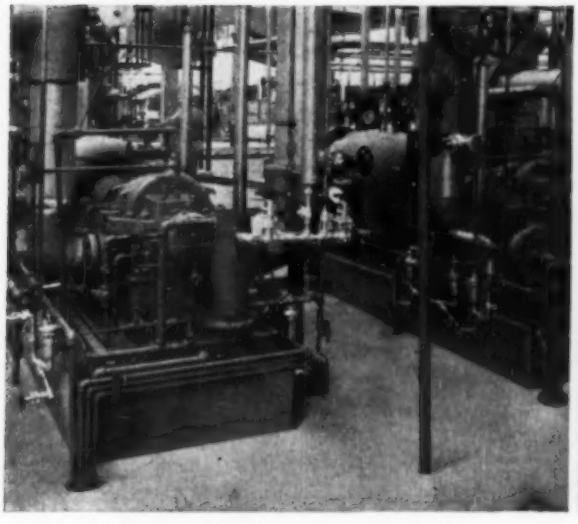
CITY & STATE.....

Semi-commercial facilities involving the isobutylene oxidation process of producing methacrylic acid and methacrylate esters went on stream at Escambia Chemical in May. Plant sites are being investigated for large scale production.

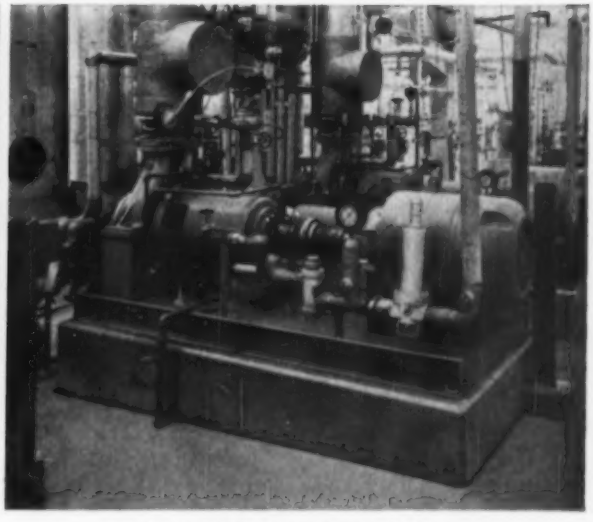
Grace

pumps polymers at Baton Rouge

with I-R PROCESS PUMPS



I-R Class GTR two-stage feed pumps.



I-R Class CSFL single-stage refinery pumps.

These are but a few of the many I-R process pumps installed at W. R. Grace & Company's 50,000,000 lb/yr polyethylene plant at Baton Rouge, La., designed and constructed by Fluor Corp.

Here a pump failure could cause real trouble—*costly* trouble. The extra quality and dependability of Ingersoll-Rand pumps is the best assurance of continuous production.

Play it *safe* with process pumps by Ingersoll-Rand—the most experienced pumps your money can buy.

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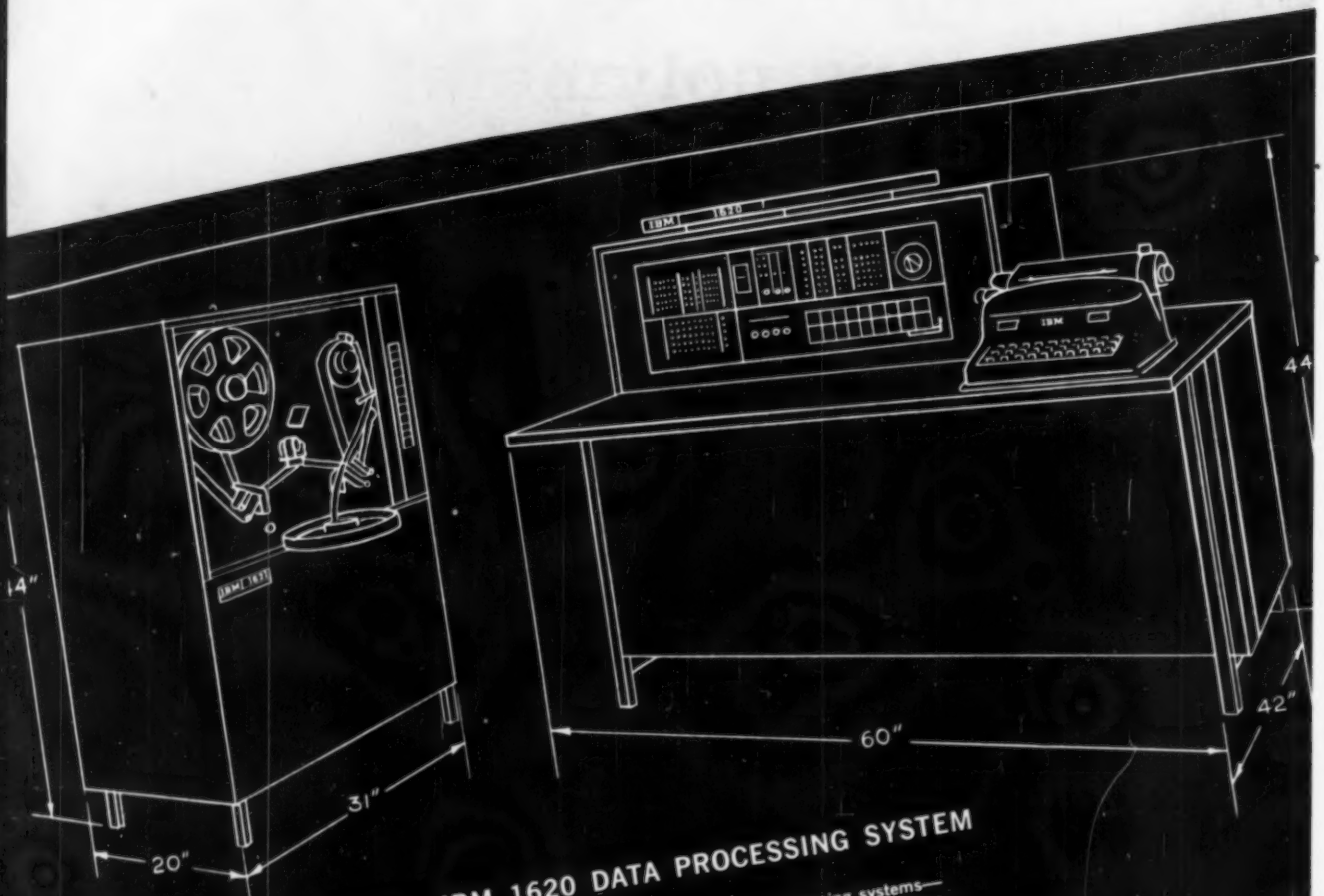
COMPRESSORS • GAS & DIESEL ENGINES • PUMPS • AIR & ELECTRIC TOOLS • CONDENSERS • VACUUM EQUIPMENT • ROCK DRILLS

For more information, turn to Data Service card, circle No. 50

For more information, circle No. 99



SPECIFICATIONS: IBM 1620 DATA PROCESSING SYSTEM

Core storage—20,000 digits
Automatic operation—stored programming
High computing speed—20 microsecond machine cycle
Powerful instructions with two data addresses
Decimal and alphabetic
Variable field and record length—any size numbers

Advanced programming systems—
Fortran and symbolic programming
Compatibility with other computers through Fortran
Simple console with logging features.
Self checking throughout
Transistorized circuitry—
compact, economical, reliable
Paper tape input and output

The 1620 will meet technical computing requirements too complex for the conventional desk-type calculator. It provides many advantages of larger systems at a much lower cost. In addition, it can be used to support other data processing systems such as the IBM 650, 704, 705, 709, 7070 and 7090.

Information enters the system from the typewriter of the 1620 Central Processing Unit, or from the 1621 Paper Tape Reader. Output is to the typewriter or 961 Tape Punch.

Machine	Weight in lbs.	Current Requirements	Power cord	Interconnecting cable	Heat Load Specification BTU/Hr
1620	1,000	20 Amps., 115 Volts, single phase	10' 3-Wire for 115 and 230 Volts	10' signal	5,000
		10 Amps., 230 Volts, single phase		10' power	
		6.5 Amps., 208 Volts, three phase	10' 4-Wire for 208 Volts	—	2,000
1621	280	—	—	—	

FREE YOUR ENGINEERING STAFF FOR MORE CREATIVE WORK . . .

IBM 1620 LOW-COST, DESK-SIZE COMPUTER

RELIEVES YOUR STAFF OF TIME CONSUMING WORK

...SOLVES WIDE RANGE OF SPECIALIZED PROBLEMS

Problems that used to tie up your engineering staff for days can now be solved . . . with electronic accuracy . . . in minutes! The IBM 1620 is a low-cost, desk-size engineering computer that solves a tremendous range of chemical engineering problems quickly and easily. The 1620 offers you an economical way to increase staff productivity, helps pave the way for profitable growth.

The 1620 is easy to learn, easy to operate, easy to communicate with. It adapts readily to such specialized problems in the chemical industry as design development, blending problems involving matrix arithmetic, research calculations with differential equations, problems in kinetics, reactor design, statistical design of experiments, and evaluation studies employing techniques such as regression analysis.

IBM also makes available a comprehensive library of mathematical routines and programs as well as reliable customer engineering. These services supporting the 1620 are an important part of IBM Balanced Data Processing. They make it easy for you to make full use of the 1620 in your operations without delay. Like all IBM data processing equipment, the 1620 may be purchased or leased.

BALANCED DATA PROCESSING

IBM

Dept. 805
International Business Machines Corporation
112 East Post Road, White Plains, N. Y.

Please send me further information and complete specifications for the IBM 1620 Engineering Computer. I am particularly interested in:

_____
(engineering application)

NAME _____

POSITION _____

COMPANY _____

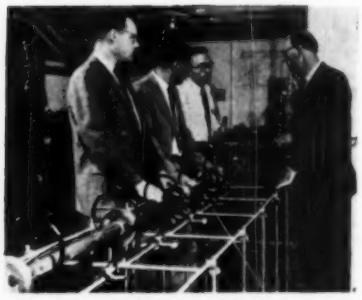
ADDRESS _____

CITY _____ ZONE _____ STATE _____

industrial news

Socal switches to methyl

TML now used in Standard of California premium gasolines is reported to be more effective anti-knock than TEL, also provides economical upgrading of road octane number.



This shock tube for determining relative stabilities of lead compounds provided important clues in California Research development of TML.

TETRAMETHYL LEAD, now being used in premium gasolines by Standard Oil of California, is proving to be more effective as an anti-knock than the conventional tetraethyl, the company says. The first anti-knock agent other than tetraethyl to be used on a commercial scale in more than 38 years, TML, tradenamed methyl, has completely replaced ethyl in Socal's premium gas. In regular and super-premium fuels, both TML and TEL are still being used.

In the course of several years of anti-knock additive research at California Research, it was found that TML is superior to TEL in high octane, high aromatic gasolines. Catalytically reformed stocks, the heart of most modern high octane gasolines, respond better to TML, researchers found. The pre-flame reactions of hydrocarbons causing engine knock were also studied, as was the mechanism by which antidetonants suppress shock. In shock tube studies, designed to measure thermal stabilities of anti-knock compounds, it was found that TML is more effective in suppressing pre-flame reactions.

Aromatic content

It became more pressing, however, to put this information into practice since the high compression ratio cars of today have higher cycle temperatures than older cars, and TEL breaks down too early in the cycle to give maximum effectiveness. The recent change in composition of gasolines to those with an aromatic content of 30 percent and higher particularly favors the use of TML.

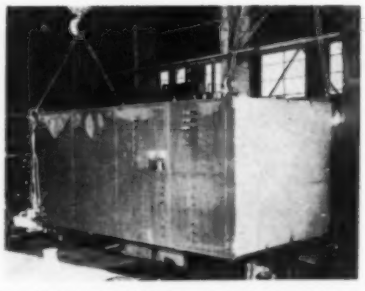
In the direct replacement of TEL by TML on an equivalent lead concentration basis, the road octane quality of high octane premium gas is raised from one to two octane numbers in most cars. Tests were conducted with six commercial motor fuels in the 98 to 102 research octane range, having 20 to 50 percent aromatic content. Road octane gain over TEL varies among cars, but, according to Socal, methyl is always more effective than TEL in commercial production premium fuels.

At the moment, TML is costing refiners more than TEL on a contained lead basis, but Standard predicts that the price will decrease. TML, they say, will eventually replace much of the TEL now in use in the average automatic transmission car, and in some of the stick shift cars. At its present price, Socal says, TML can provide a road octane improvement considerably cheaper than can be obtained through extra processing.

Socal uses the entire present national production of TML. It is supplied by Ethyl, from its Baton Rouge La. plant, and by Du Pont, from its Chambers Works at Deepwater Point, N.J. Du Pont is constructing an addition to the plant, a separate unit, slated for completion in eight or nine months.

New low temperature methane plant

Low temperature type methane purification plant of Air Products is on stream at Solvay Process, Moundsville, West Va., will make chlorinated hydrocarbons.



Insulated "cold box" containing all low temperature equipment for Solvay's new methane purification plant is hoisted on flat car for delivery.

A METHANE PURIFICATION PLANT went on stream recently at Solvay Process Division, Allied Chemical, Moundsville, West Va. The low temperature type facility will use the 99.99% pure product to manufacture chlorinated hydrocarbons such as carbon tetrachloride, chloroform, methyl chloride and methylene chloride.

In the process, methane-rich feed gas first enters a caustic scrubber for removal of CO_2, then an alumina-filled drier vessel which is one of two automatically alternated. The dried feed is then cooled in the heat exchanger by outgoing fuel gas and pure methane from the column. After leaving the heat exchanger, the feed gas, in going through an expansion valve, drops in temperature. It then enters the distillation column from which methane is taken from the top as a gas. The heavier hydrocarbons which are withdrawn from the bottom as liquid are passed back through the heat exchanger to recover the refrigeration.

The pure methane from the top of the column is divided into two streams. One is fed into the main heat exchanger where it cools the incoming feed stream and emerges as methane product at ambient temperature. The other portion of the stream is passed through the recycle heat exchanger and is compressed by the

continued on page 98

For more information, circle No. 101 ➤

built by Badger for

ATLANTIC

220 million lb/yr. wax plant of advanced design completed in 61 weeks

One of the largest, most flexible wax manufacturing plants ever constructed has recently been completed by Badger at the Atlantic Refining Company's Philadelphia refinery. The classic and widely used MEK solvent process* was the starting point for this ultra-modern plant. From there, Badger engineers created an unusually versatile design . . . a plant capable of processing eight different feedstocks through fourteen operations to produce corresponding grades of paraffin waxes (oil content 0.2%).

Plant capacity (265 tons/day) and the number and variety of processing steps made economical design a major engineering undertaking. Examples: the filter section includes fourteen 700 sq. ft. units of an improved design — the largest in the petroleum industry; the two compressors in the massive refrigeration section have a combined rating of 5,800 h.p. — equivalent to the capacity required to produce 4,200 pounds of ice per minute; the chiller-exchanger section consists of 33 units (sixteen scraped-pipe exchangers, seventeen scraped-pipe chillers) in a novel arrangement that simplifies maintenance and operation.

In spite of its size and the complexity of the engineering problems involved, Badger completed Atlantic's plant in less than fourteen months. This project is another example of how Badger engineering skill helps leading companies get more efficient, economical plants. Isn't this the type of service you deserve?

New 8-page brochure describing the Atlantic Wax Manufacturing Plant available on request. Write for your copy.

*Texaco Dev. Corp. Licensor

built by **BADGER**

INTERNATIONAL DESIGNERS • ENGINEERS • CONSTRUCTORS

THE BADGER COMPANIES

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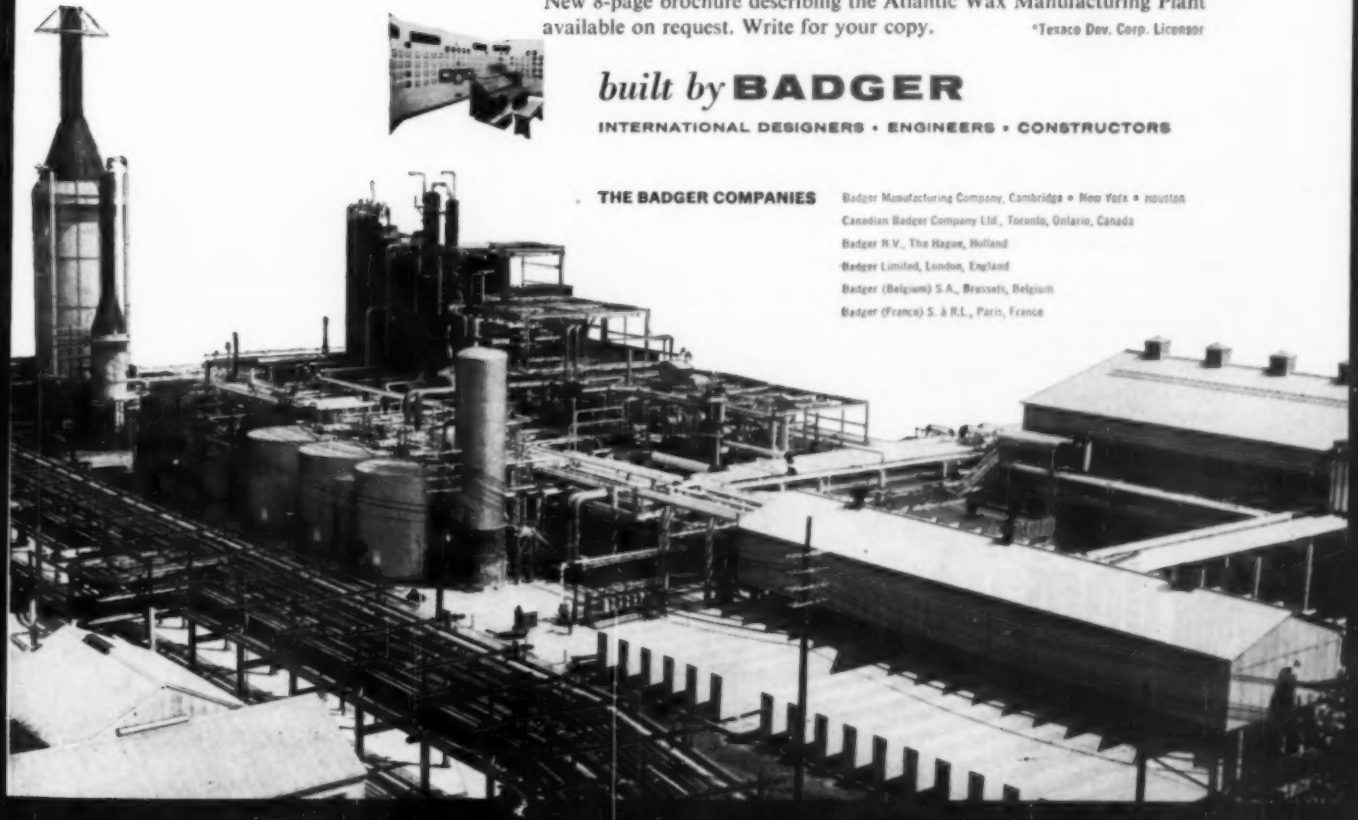
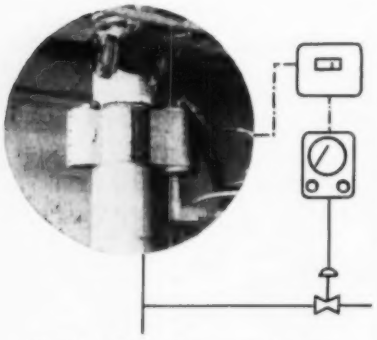


guarantees continuous, accurate, automatic density control!

Like a "sentinel" that never tires or sleeps, Ohmart Density Gages guard product quality, improve system efficiency, multiply your profits. Ohmart offers the most complete, standard line of nuclear gaging equipment for controlling the density variable in liquids or slurries, level measurement, and interface detection.

Ohmart Profit-Making Advantages:



Typical Ohmart system for controlling specific gravity or density by actuation of a valve.

- Each Ohmart installation carries a performance guarantee.
- Maintains single optimum point of density, automatically, by direct measurement.
- Quickly pays for itself through increased production and higher net profits; reduced variable and capital costs.
- Saves manpower, eliminates human error, cuts operating costs.
- System is ruggedly constructed, has no moving parts. Gages are not in contact with the media. There is nothing to clog, wear out, or corrode.
- Measures density to repeatabilities of 0.0005 specific gravity units or within 2% of selected range.

Atomic Operation:

Ohmart system employs a gamma radiation source with the patented Ohmart Cell as the detector which converts gamma radiation directly into electrical energy. Materials placed between the source and the cell absorb the energy in proportion to the density. As a result, cell output current is a measurement of the density. The output current is amplified and fed to any standard potentiometric recorder/controller. Departures from the optimum control point actuate controls necessary to bring the system back to optimum density. The gamma source is properly shielded for complete safety. Low radiation level cannot affect the materials measured.

For full details, write for Bulletin 105-C.

ohmart

The Ohmart Corporation
2230 Bogen St., Cincinnati 22, Ohio

Engineering representatives in principal areas

For more information, turn to Data Service card, circle No. 45

New methane plant

from page 96

recycle compressor. The high pressure stream from the compressor then goes out through the recycle heat exchanger where it is cooled by incoming product. After the methane is expanded to form liquid for refluxing the column, the gas portion of the reflux stream is removed in the phase separator, and joins the product stream from the top of the column.

The plant was designed by Air Products, Allentown, Pa. ≡

The customer comes first

Newly-dedicated Tarrytown, N.Y. lab of Union Carbide Chemicals will be devoted to sales-oriented research.

"A CHEMICAL SALESMAN must offer more than a good product. He must offer the technology needed to help his customers use products profitably." The speaker—J. A. Field, Union Carbide Chemicals' vice-president for marketing. The occasion—formal dedication of Union Carbide's new customer service lab at Tarrytown, N.Y.

The new facility unites customer-oriented research activities formerly carried out in such scattered localities as Mellon Institute in Pittsburgh, South Charleston, W. Va., Whiting, Indiana, Bound Brook, N.J., Tonawanda, N.Y., and Millwood, N.Y.

Technical Service Laboratory at Union Carbide Chemicals at Tarrytown, N.Y.

Staff will consist of about 100 scientists and engineers, with a supporting and administrative group of about 50.

Function of the new lab, according to Carbide will be:

- To assist customers in proper use of the company's products;
- To create an awareness of changing markets which can affect current and future sales;
- To foster development of new

continued on page 100

Second in a series of check lists on Annin features

CHECKUP on your Control Valves... CHECKOFF these Annin Advantages*

***Providing the optimum in design and performance features**

MINIMUM PARTS and simplicity of construction in Pneumatic Position Unit.

THREE POINT guiding and self lubricating seals in pneumatic piston actuators.

ADJUSTABLE TOP LOADING of piston permitting optimum control performance over maximum range of conditions on pneumatic positioning actuator.

BODY ORIENTATION as specified on any three-way valve at no extra charge.

CORNER VALVE BODY construction ½" through 2" in all body ratings converted on job site.

WIDE SELECTIVE range of reduced port (Pee Wee construction) trim available with CV ranges 2.5, 1.5, 1.0, 0.60, 0.25, 0.10, .063, .040, .025, .016, .010, at no extra charge.

REDUCED PORTS stepped down three or more sizes interchangeable in all models.

MINIMUM CV available of .000001.

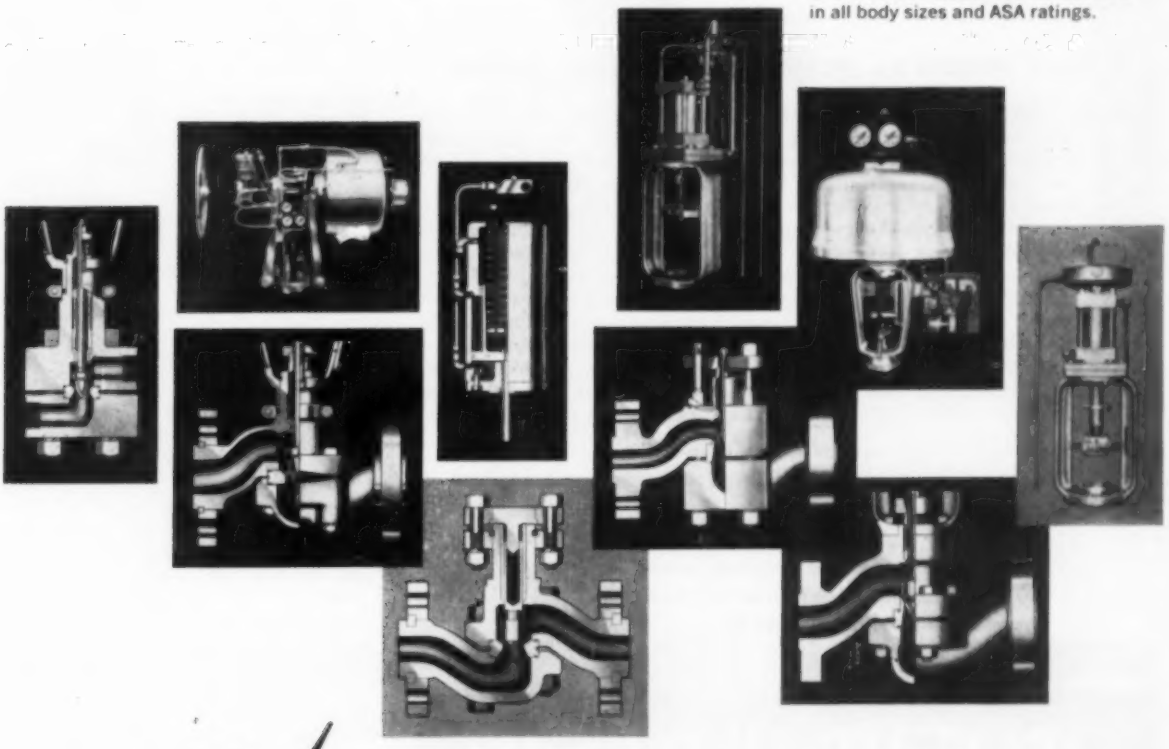
NO EXTRA CHARGE for reduced ports in any model 1 inch and under.

SOFT SEAT construction for guaranteed bubble tight shut off available in all models at minimum cost.

WIDE CHOICE of special body gasketing for all applications within temperature-pressure limitations of any valve.

TEFLON CHEVRON packing standard on all valves. Other types on request.

SPLIT BODY CHECK VALVE available in all body sizes and ASA ratings.



Annin **VALVES**

THE ANNIN COMPANY
1040 South Vail Avenue
Montebello, California

For more information, turn to Data Service card, circle No. 61

• HOT MINERAL ACIDS • ORGANIC ACIDS

The experience of our engineers over a long span of time has developed many highly productive, highly successful and highly profitable leaf filter designs constructed with a variety of materials to handle hydrochloric, sulfuric, fumaric and other mineral or organic acids. These feature tank linings of Hypalon, butyl rubber, plastisol and vinyl coatings to name a few materials currently being used for these strong acids. Leaf designs include materials of zirconium, titanium, polypropylene and PVC which have been proven for these services. Quick/Change polypropylene bags are common to most installations of this type and facilitate installation on leaf frames without operator sewing. Style of installation gives full security and tight surfaces which improve sluicing cake discharge economy. Additional features such as the efficient Rotary-Sluice, Reslurry Air Ring, Filtrate "Policeman" protective assemblies and Spacers are produced in this same variety of materials. Basic Vertical and Horizontal Tank Leaf Filters are available in these materials and are much less expensive than you may think.

You are invited to use this experience to virtually eliminate corrosion problems and improve your filtering operation. Our staff and sales agents are ready to help you. Why not drop us a line, now!

If you have a hot acid problem, write for our confidential filtration data sheet or phone Victoria 5455.

BF | BUFFALO FILTERS, INC.
1807 ELMWOOD AVE. BUFFALO 7, N. Y.

For more information, turn to Data Service card, circle No. 90

Customer service

from page 98

product uses to diversify and expand existing markets;

- To follow customer requirements for specific chemicals;
- To aid in training and retraining sales representatives.

Work is already under way at the Tarrytown lab in 29 major industry groups which include, automotive, petroleum, polyether foams, aerosol propellents, refrigerants, textiles, plasticizers, water-soluble chemicals, detergents and household products, gas purification, and surface coatings. =

In a major modernization program at the Texas City refinery, American Oil has contracted for two new units, a 150,000 bbl./day crude running unit and a 47,000 bbl./day catalytic cracking unit. A third project, an alkylation unit with 14,500 bbl./day capacity, is also planned. Main purpose of these additions is to increase operating efficiency and product quality, although capacity will also increase a bit.

An expansion in carbon black capacity at J. M. Huber's plant in Eldon (Baytown) Texas, will produce 60 million additional pounds a year. Two units are under construction—one for intermediate super-abrasion furnace black, and one for fast extruding furnace black. Both should be complete by 1961.

A 25,000 tons per year butadiene unit, Houdry Dehydrogenation Process, has gone on stream at the Japan Synthetic Rubber Co., Yokkaichi, Japan. It is part of an integrated synthetic rubber plant, designed to accommodate a variety of feed stocks, ranging from straight run butane to butane-butylene-butadiene combinations.

The Algerian firm, Compagnie Francaise des Petroles, is expanding its crude oil stabilization plant at Hassi Messaoud, in the Sahara. Current production of 54,000 barrels daily will increase to 100,000. Plant design by Stone & Webster, provides for removal of large quantities of wild gas from the well fluids, with maximum practical amounts of stabilized crude retained. At present, the separated gases are being flared because of a lack of immediate markets. But a portion may ultimately be recovered by removal of liquefied petroleum gas. The balance may be returned to the wells for conservation purposes.

FLAVOR LADEN

RICH INSTANT COFFEE IS SWENSON "ENGINEERED"

Swenson engineers working with leading coffee roasters have developed spray drying equipment which produces the finest quality instant coffee. The many Swenson Soluble Coffee Dryers in use today are proving that flavor-laden instant coffee is profit-laden too. To capitalize on a wealth of experience in equipment for the food and other process industries, call on Swenson Evaporator Company.

FREE BULLETIN . . . for more information on Swenson Spray Dryers, write for Bulletin SW 401 today.
SWENSON EVAPORATOR COMPANY,
15690 Lathrop Avenue,
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PROVED ENGINEERING FOR THE PROCESS

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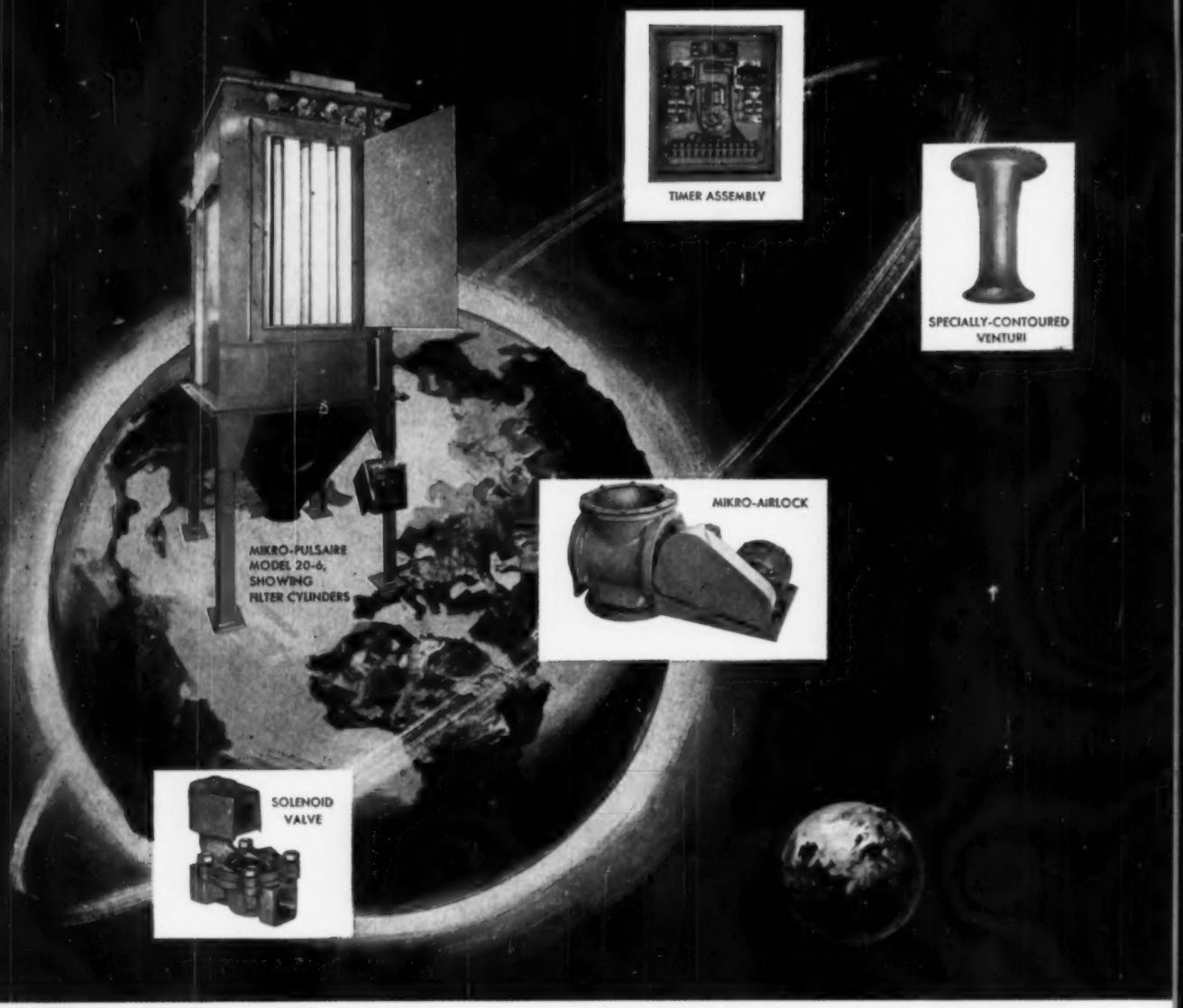
WHITING—MANUFACTURERS OF CRANES; TRAMBEAM HANDLING SYSTEMS; TRACKMOBILES; FOUNDRY AND RAILROAD EQUIPMENT.

For more information, turn to Data Service card, circle No. 52



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FOR MORE INFORMATION CIRCLE NUMBERS

SUBJECT GUIDE to advertised products

EQUIPMENT

Actuators, valve (p. 134). Details from Fisher Governor on Type 470 P.O.P. **Circle 21.**

Agitators, propeller, top-entering (p. 90). Bulletin 220 from Chemineer. **Circle 68.**

Blenders (p. 141). Nine standard models with capacities to 900 cu. ft. Bulletin 080B from Sturtevant Mill. **Circle 11.**

Castings, high-alloy (p. 127). Bulletin 3150 G from Duraloy. **Circle 5.**

Centrifugals (p. 26). Details of the "Batch-O-Matic" from Tolhurst Div., American Machine and Metals. Bulletins. **Circle 106.**

Centrifugals (p. 89). Bulletin 1286 from Sharples gives full details of the C-41 "Super-D-Hydrator." **Circle 12.**

Coils, heat-exchanger, fin-type (p. 118). Bulletin S-55 from Aerofin. **Circle 2.**

Compacting Process (p. 32). Converts waste fines into salable product. Details from Allis-Chalmers. **Circle 85.**

Comparators, colorimetric (p. 137). Free Handbook from W. A. Taylor has 101 pages of technical data. **Circle 25.**

Compressors (p. 78-79). Technical data from Cooper-Bessemer. **Circle 20.**

continued on page 104

MATERIALS

Coatings, protective (p. 131). Maintenance Chart No. 5 from Carboline gives complete details on 17 different maintenance systems. **Circle 54.**

Coatings, protective, high-temperature (p. 142). Brochure and free sample offer from Midland Industrial Finishes. **Circle 67.**

Cobalt-60 (p. 31). Complete Cobalt-60 service and source range offered by Atomic Energy of Canada. Technical data. **Circle 49.**

Ethyl Alcohol (p. 19-20). New Catalog from U.S. Industrial Chemicals gives detailed info on pure ethyl alcohol, denatured alcohol formulations. **Circle 123-1.**

Gases, compressed (p. 83). New Catalog from Matheson gives prices and data on 85 gases, mixtures, gas handling equipment. **Circle 66-2.**

Gases, compressed (p. 83). Matheson offers Wall Chart "Using Compressed Gases" showing safe methods of handling compressed gases. **Circle 66-1.**

Packing, asbestos, braided (p. 155). Catalog and Price List SLP-659R from Greene, Tweed. **Circle 22.**

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RVICES

nputer Systems (p. 116). Info from
neral Motors Research Laboratories
"DYANA," new automatic analysis
programming system. **Circle 13.**

ign and Construction, copper re-
ries (p. 22-23). Brochure from
W. Kellogg on details of new copper
nery built for Kennecott Copper.
cle 28.

ign and Construction, ethylene
nts (p. 6-7). Technical data from
mmus. **Circle 63.**

ign and Construction, nitrogen re-
val plants (p. 107). Info from Ameri-
Air Liquide on process to upgrade
ural gas. **Circle 114.**

ign and Construction, wax plants
97). New 8-page Brochure from
lger describes new 220 million lb./
wax plant built for Atlantic Refin-
Circle 101.

rication, process equipment (p. 4).
letins HE and CI from Downingtown
Works describes fabrication of
ssure vessels and heat exchangers.
cle 65.

rication, process equipment (p.
. Data from American Machine and
ails on Tolhurst centrifugals, Niag-
pressure filters, FEinc continuous
rs, FEON filter media. **Circle 105.**

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JUNE 1960

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FREE TECHNICAL LITERATURE

301	302	303	304	305	306	307	308	309	310	311	312	313	314	315
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EQUIPMENT *from page 103*

Computer, engineering (p. 94-95). Info from IBM on the 1620, low-cost, desk-size engineering computer. **Circle 99.**

Conductivity Cells (p. 144). Complete Catalog of conductivity cells, measuring instruments and equipment. Industrial Instruments, Inc. **Circle 30.**

Controller, elapsed time (p. 21). Catalog 08-705 from Daystrom, Weston Instruments Div., gives info on new recorder that controls pressure, temperature automatically. **Circle 125.**

Control Systems, visual (p. 155). Booklet BE-10 from Graphic Systems. **Circle 59.**

Conveyors, pneumatic (p. 119). Technical info from Fuller on the "Airslide" fluidizing conveyor. **Circle 7.**

Conveying Systems, pneumatic (p. 122). Bulletin 143-B from Spencer Turbine gives diagrams of typical systems. **Circle 38.**

Crushers (p. 132). For processing and recovery operations. Details from American Pulverizer. **Circle 17.**

Detector, voids (p. 84). Technical data and Bulletin from Tinker & Rasor describes the "Holiday Detector" for location of voids in protective coatings. **Circle 39.**

Dew Point Instrument (p. 143). Info from Illinois Testing Laboratories on the Alnor "Dewpointer." **Circle 14.**

Dryers, batch-type (p. 126). Complete Specification Bulletin from Despatch Oven. **Circle 41.**

Dryers, drum, rotary (p. 14). Technical data from Boardman on fabrication of rotary drum dryers, many other types of processing equipment. **Circle 18-1.**

Dryers, "Rota-Cone" (p. 121). Full details in 12-page Brochure from Paul O. Abbe. **Circle 29.**

Dryers, spray (p. 101). Bulletin SW 401 from Swenson Evaporator. **Circle 52.**

Dust Collectors (p. 80). Complete technical info from Fly Ash Arrestor Corp. **Circle 112.**

Dust Collectors (p. 102). Filtering efficiency of 99.9% plus on wide variety of dusts. Bulletin 52A from Pulverizing Machinery Div., Metals Disintegrating. **Circle 24.**

Equipment, corrosion-resistant (p. 12). Info from American Hard Rubber on rubber-lined piping, fittings, pumps, plastic fittings. **Circle 35.**

Fans, stainless (p. 30). Specially-designed for corrosive fumes, abrasive materials, extremes of temperature. Info from Garden City Fan & Blower. **Circle 47.**

Filters (p. 27). Flow rates from 5 to 1,000 gal./min. Bulletins from Niagara Filters, Div. of American Machine and Metals. **Circle 107.**

Filters (p. 28). Data from FEinc Div., American Machine and Metals, on string discharge, precoat, roller discharge, and horizontal filters. Bulletins. **Circle 108.**

Filters, leaf (p. 100). Filtration Data Sheet from Buffalo Filters. **Circle 90.**

Filters, rotary vacuum (p. 77). Bulletin from Bird Machine gives details of the Bird-Prayon tilting-pan, rotary vacuum filter. **Circle 33.**

Filter Media (p. 29). Natural and man-made. Details from FEON Div., American Machine and Metals. **Circle 109.**

Filter Paper (p. 125). Technical data and free sample folder available from Eaton-Dikeman. **Circle 111.**

Flowmeters, turbine-type (p. 87). Capacities from 0.1 to 40,000 gal./min. Catalog from Potter-Bowser Div., Bowser, Inc., on the "Pottermeter." **Circle 34.**

Gauges (p. 140). Brochure from Kunkle Valve gives data on new gauges, plus specification data. **Circle 58.**

Gauges, density (p. 98). Bulletin 105-C from Ohmart describes nuclear gauging equipment for controlling density in liquids or slurries, level measurements, interface detection. **Circle 45.**

Gauges, liquid-level (p. 13). Bulletin CP3705 from Vapor Recovery Systems gives all details of Dynamatic 8400 Series power-driven tank gauges. **Circle 86.**

Heat Exchangers (p. 90). Bulletins 120, 124, 135 from Niagara Blower give technical details of the "Aero" heat exchanger. **Circle 36.**

Heat Exchangers (p. 135). General Catalog from Engineers and Fabricators. **Circle 44.**

Heat Exchangers (p. 137). Info from Western Supply, Heat Exchanger Div. **Circle 26.**

Heating Units, induction, high-frequency (p. 138). Info from Lepel High Frequency Laboratories. **Circle 10.**

Mill, cage (p. 140). Complete technical info from Stedman Foundry and Machine. **Circle 37.**

Mills, grinding, fluid energy (p. 10). Complete technical info from Fluid Energy Processing & Equipment on "Jet-O-Mizer" mills, "Jet-O-Clone" dust collectors, testing and custom grinding services. **Circle 6.**

continued on page 106

MATERIALS *from page 103*

Polyethylene Film, microporous (p. 19-20). Info from U.S. Industrial Chemicals on new technique for producing microporous polyethylene films. **Circle 123-4.**

Sodium Dispersions (p. 19-20). Info from U.S. Industrial Chemicals on commercially available types of sodium dispersions. **Circle 123-2.**

Sulfur (p. IBC). Info from Freeport Sulphur on new off-shore project at Grand Isle. **Circle 134.**

SERVICES *from page 103*

Fabrication, process equipment (p. 82). Data from Renneburg on kilns, combustion equipment, calciners, evaporators, mixers, conveyors, etc. **Circle 42.**

Fabrication, process equipment (p. 133). Intricate fabrication in stainless, aluminum, Monel, nickel, Inconel, all clad materials, nickel-plated steel. Data from Koven Fabricators. **Circle 124.**

Fabrication, process equipment, rubber-lined (p. 81). Bulletin from Industrial Filter & Pump Mfg. describes facilities for design, engineering, production of rubber-lined equipment. **Circle 15.**

Fabrication, process equipment, stainless (p. 92). Data from Chester-Jensen on heaters, heat exchangers, vats, storage tanks. **Circle 51.**

Heat Transfer Papers (p. 140). Proceedings of the 1960 Heat Transfer and Fluid Mechanics Institute. Info from Stanford University Press. **Circle 43.**

Sealing Technique for Polyethylene Pipe (p. 19-20). Details from U.S. Industrial Chemicals on new heat-sealing technique for polyethylene pipe and fittings. **Circle 123-3.**

Anhydrous Ammonia
Brine
Caustic Catalyst
Caustic, 50% Solution
CO_2, Liquid
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WHAT CHEMICALS ARE GIVING YOU PUMPING PROBLEMS?

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CEP'S DATA SERVICE—Subject guide to advertised products and services

CIRCLE CORRESPONDING NUMBERS ON DATA SERVICE CARD

EQUIPMENT *from page 104*

Mixers (p. 9). Engineering Manual K-57 from Baker Perkins, Chemical Machinery Div., gives complete details of the "Ko-Kneader." **Circle 104.**

Mixers (p. 123). Technical info from Gabb Special Products on the "Shear-Flow" mixer. **Circle 53.**

Mixers (p. OBC). Choice of standard designs in sizes up to 500 hp. Technical data from Mixing Equipment Co. **Circle 23.**

Nozzles, spray (p. 24). Catalog 1 from Monarch Mfg. Works describes complete line. **Circle 60.**

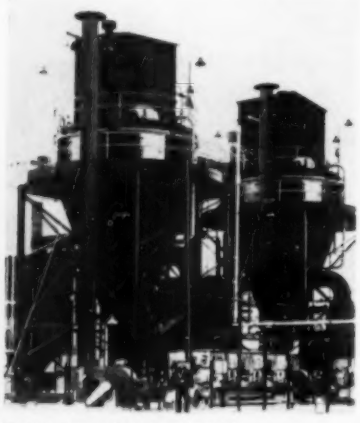
Nozzles, spray (p. 134). Catalog from Wm. Steinen Mfg. on solid-cone and flat-spray nozzles. **Circle 89.**

Nozzles, spray (p. 141). Comprehensive Catalog from Binks Mfg. **Circle 3.**

Packing, tower (p. 111). Comprehensive Booklet from Harshaw Chemical discusses application of "Tellerettes" to tower packing problems. **Circle 55.**

Packers, vibrating (p. 5). For boxes, cans, cartons, kegs, drums, barrels, up to 750 lb. Bulletin From B. F. Gump. **Circle 40.**

DEVELOPMENT OF THE MONTH



TWIN SPRAY DRYERS
(Circle 602 on Data Post Card)

The two Nerco-Niro spray-dispersion dryers shown above were installed at the Dow plant in Michigan where a gentle process was required to dry a heat sensitive plastic from a wet cake to a free flowing powder.

The new dryers feature an atomizer of novel design to handle unconditioned wet cake feeds. The material is dried to a moisture content of 0.1% without recycling and requires no subsequent grinding or screening.

For more information from Nichols Engineering & Research Corp., Circle 602 on Data Post Card.

Processor (p. 136). Info from Kontro on the "Ajust-O-Film," centrifugally-wiped, thin-film, pilot-plant scale processing unit. **Circle 113.**

Pumps, canned (p. 109). Pressures to 5,000 lb./sq. in., temperatures to 1,000°F, capacities to 600 gal./min. Composite Bulletin 1100 from Chempump. **Circle 19.**

Pumps, corrosion-resistant (p. 85-86). Info from Eco Engineering on pumps and valves for handling corrosive and hazardous processing fluids. **Circle 122.**

Pumps, process (p. 93). Technical data from Ingersoll-Rand. **Circle 50.**

Pumps, process (p. 105). From 25 to 2,500 hp, presures to 50,000 lb./sq. in. Complete data from Aldrich Pump. **Circle 1.**

Pumps, rotary gear (p. 142). New Bulletin G-1 from Schutte and Koerting gives full details on standard models. **Circle 27.**

Pumps, sealless, plastic (p. 130). Catalog and specifications info from Vanton Pump & Equipment. **Circle 57.**

Reactors, aluminum (p. 113). Complete technical info from General American Transportation. **Circle 126.**

Reactor, bench-scale (p. 132). Catalog Sheet 9-V from Pressure Products Industries gives details of 300 ml, 5,000 lb./sq in. bench-scale reactor. **Circle 31.**

Refrigeration Unit (p. 18). Details from Croll-Reynolds on the "Chill-Vactor," vacuum refrigeration unit. **Circle 4.**

Rotameter, transmitting, pneumatic (p. 117). Bulletin 18N from Schutte and Koerting gives details of the new Model 58. **Circle 46.**

Rupture Discs (p. 139). Sizes from 1 to 24 in., rupture pressures from 4 to 850 lb./sq. in. Catalog from Fike Metal Products. **Circle 92.**

Scrubber, fume (p. 36). Data from U.S. Stoneware on the "Cyclonaire," available in 4 sizes to 6,000 cu. ft./min. Bulletin FW-10. **Circle 96.**

Separators, entrainment, cyclone (p. 14). Data from Boardman on entrainment separators, other processing equipment. **Circle 18-2.**

Tanks, rubber-lined (p. 135). Wide variety of rubber and plastic linings. Data from Gates Rubber. **Circle 56.**

Tanks, wood, polymer-lined (p. 143). New Tank Industry Bulletins on comparative costs, maintenance, chart of chemicals and effects, thermal qualities. Wendnagel. **Circle 88.**

Valves, control (p. 99). Info from Annin on complete line. **Circle 61.**

Valves, "Flo-Ball" (p. 91). Data from Hydromatics on new design offering minimum pressure drop, no lubrication. **Circle 9.**

Valves, needle, all-plastic (p. 34). Sizes to 1 in., pressures to 75 lb./sq. in., temperatures to 140°F. Bulletin 5C-16 from Foxboro. **Circle 16.**

Valves, plug, jacketed (p. 30). Complete Catalog from Parks-Cramer. **Circle 130.**

Valves, plug, non-lubricated (p. IFC). In ductile iron or stainless, screwed or flanged ends, ½ through 6 in., with 150 lb./sq. in. rating. Bulletin V/12 from Duriron. **Circle 64.**

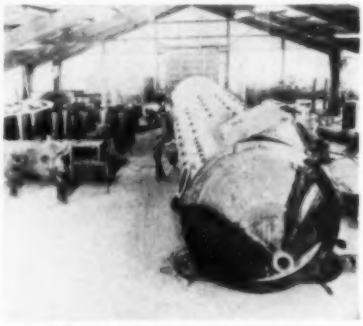
Valves, porcelain (p. 11). Catalog 567 from Lapp Insulator gives specifications of Y and angle valves, ½ to 6 in. sizes. **Circle 87.**

Vessels, reaction (p. 139). Info from Bethlehem Foundry & Machine on design and fabrication facilities. **Circle 32.**

Vessels, transport (p. 143). For handling liquids and semi-solids. 50 to 150 gal. capacities. Details from Hubbert. **Circle 62.**

Water Treating Equipment (p. 136). Complete plants for demineralization, dealkalizing, clarification, silica removal, water softening, iron and manganese removal. Catalog from Hungerford & Terry. **Circle 8.**

DEVELOPMENT OF THE MONTH

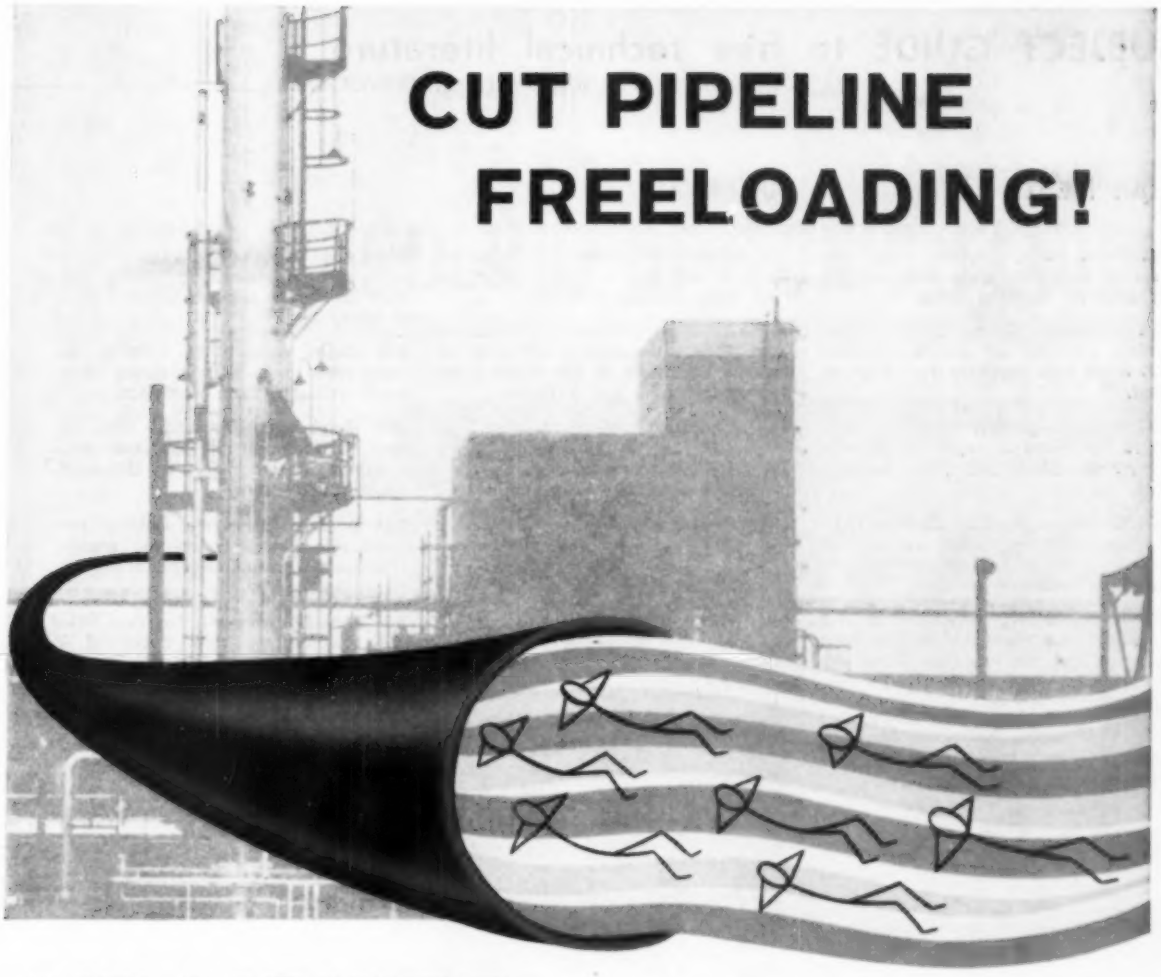


CHEMICAL FUME SCRUBBER
(Circle 601 on Data Post Card)

The huge chemical fume scrubber shown above, reported to be the largest single unit of industrial equipment ever fabricated from reinforced plastic, was designed and engineered by the Buffalo Forge Co. for an installation handling large volumes of corrosive fumes. The unit, which is over 47 ft. high and 10 ft. in diameter, was designed to handle 42,000 cu. ft./min. of dust-laden gases. The scrubber was fabricated by du Verre, Inc. using Hetron® 92, a fiberglass-reinforced polyester plastic material from the Durez Plastics Division of Hooker Chemical Corp.

At left is shown a 10,000 cu. ft./min. scrubber, in the background are sections of the ductwork.

For more information from Buffalo Forge Co., Circle 601 on Data Post Card.



AIR LIQUIDE eliminates "dead head" gas by low-temperature separation

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For more information, turn to Data Service card, circle No. 114

SUBJECT GUIDE to free technical literature

CIRCLE CORRESPONDING NUMBERS ON DATA SERVICE CARD

EQUIPMENT

301 Burst discs, graphite. Data from Kearney Industries gives sizes, ratings for graphite bursting discs.

302 Catalytic Units. Brochure describes unit for air pollution control and waste heat recovery from Oxy-Catalyst.

303 Chromatography. A 33-page Brochure describes a vapor fractometer from Perkin-Elmer and gives operating data.

304 Chromatography. A 69-page Catalog contains description of modular instruments for gas chromatography. Research Specialties Co.

305 Coils, heating. New 44-page Bulletin from American-Standard includes technical info for selecting heat transfer coils.

306 Collector, dust. Dust control Bulletin 279C from American Air Filter describes fabric collectors for reclaiming dry fines.

307 Compressors, air. Brochure outlines 23 air compressor models for 75-2000 h.p. service from Clark Bros. Co.

308 Computer. Detailed information from Sperry Rand describes new Univac III computer system.

309 Control System. Bulletin CP-3708 describes system for instantaneous control of pumps, valves, etc. Vapor Recovery Systems.

310 Controls, automatic temperature. An Engineer's steam-water Manual from Powers Regulator Co. is a guide for selection of controls.

311 Conveyor, pneumatic. Bulletin describing advantages of pneumatic conveying systems from Spencer Turbine Co.

312 Dampener, pulsation. Information from Ball Mfg. Co. describes new flanged pulsation dampener.

314 Data Processing. Publication illustrating applications of data processing and computer systems from Leeds & Northrup Co.

315 Distillation Plates. Technical Brochure describes the Kittel plate, a new form of contacting tray from Constructors John Brown Ltd.

316 Distributors, rotary. Bulletin 6506 describes rotary distributors for filters from Yeomans Brothers Co.

continued on page 110

MATERIALS

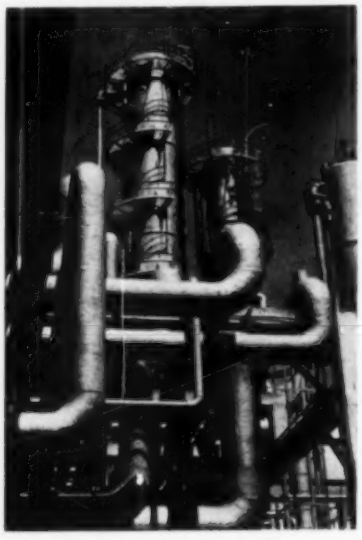
357 Alloys, heat-resistant. A Selection Guide to heat-resistant cast high alloys from Alloy Casting Institute.

358 Cationic Chemicals. Brochure from Armour presents information on cationic chemicals as conditioners for hygroscopic salts and fertilizers.

359 Chromium Chemicals. New 80-page Technical Bulletin from the Solvay Div. of Allied Chemical presents complete survey of chromium chemicals.

360 Dodecenyl Succinic Anhydride. New 29-page Technical Bulletin from Allied Chemical gives properties and applications of new anhydride.

DEVELOPMENT OF THE MONTH



CRYOGENIC INSULATION (Circle 604 on Data Post Card)

A new temperature insulation material called Foamglas produced by Pittsburgh Corning Corp. is said to withstand corrosive, salt-laden atmospheres and to prevent moisture condensation on low temperature process lines.

The new material is a cellular glass material that is impervious to vapor and moisture. Foamglas has been used for insulating piping, valves, and fittings for low temperature fractionation towers and refrigerating processes.

A typical application of Foamglas is shown above. Here the material is used for insulating at low temperature fractionation tower at a Gulf Coast refinery. The process temperature range is –150 to 160° F.

For more complete data, Circle 604 on Data Post Card.

361 Epoxy Adhesives. A 23-page Handbook of application methods for concrete adhesives offered by International Epoxy Corp.

362 Gases, compressed. Catalog lists compressed gases and regulating equipment available from Matheson Co.

363 Molybdenum Products. New 22-page molybdenum mill products specifications Booklet offered by Universal-Cyclops Steel Corp.

364 Organic Chemicals. Catalog provides information concerning organic chemicals from Allied Chemical's National Aniline Div.

365 Phenolic Materials. Two new Bakelite molding materials described in Brochure from Union Carbide Plastics Co.

366 Plastics, laminated. Selection Guide consisting of 12-page Manual and Wall Chart helps specify laminated plastics. Data from Taylor Fibre Co.

continued on page 110

SERVICES

374 Facilities, spray drying. Bulletin shows custom drying facilities available to industry from Nichols Engineering & Research Corp.

375 Fertilizer Plants. Brochure includes existing plants, flow diagrams and data to aid in designing new plants. Info from J. C. Carlile Corp.

376 Heat Transfer Area Chart. Size Selection Chart for determining heating area available from Dean Products.

377 Olefin Plants. Booklet from M. W. Kellogg describes plant design capabilities, the olefin flow process, and the future of pyrolysis in this field.

378 Products, Processes, Services. Brochure describes engineering services offered by Houdry Process Corp.

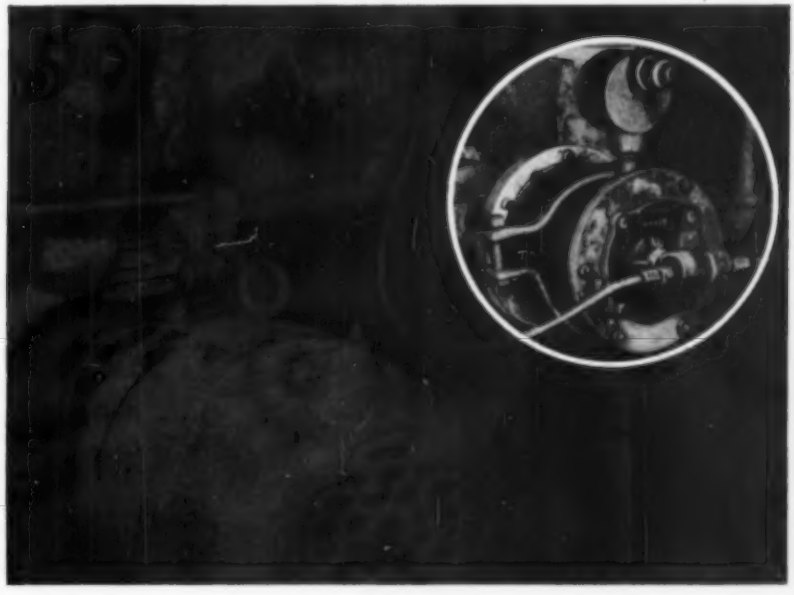
379 Services. Brochure describes the facilities, divisions, and services of Budd Co.

380 Slide Rule, Circular. A circular slide rule containing "C" and "D" scales is available from General Industrial Co.

381 Thermocouple Chart. Plastic chart with thermocouple calibration curve and radiamatic detector ranges from Minneapolis-Honeywell.

depend on
Chempump
to give you

SAFER HANDLING OF TOXIC FLUIDS



Chempump—the first canned pump—completely eliminates dangerous leakage of chlorine, mercaptans, amines, nitric acid and all other toxic fluids. Chempump is absolutely leakproof, because it's totally enclosed. There are no seals, no stuffing box, no "O" rings—no chance for hazardous vapors, contamination or waste.

External lubrication is never required, as bearings are lubricated by the pumped fluid itself. Bearings are easily changed without breaking pipeline connections. Special designs and materials available for handling fluids with pressures to 5000 psi . . . temperatures to 1000°F . . . capacities to 600 GPM. Water or steam jackets available to insure proper operation in many special applications. Most models UL approved.

These and other Chempump advantages could well be the answer to safe, efficient and economical handling of your "difficult" fluids. *Write now for composite bulletin 1100,* Chempump Division Fostoria Corporation, Buck and County Line Roads, Huntingdon Valley, Pennsylvania.

CHEMPUMP

first in the field . . . process proved

For more information, turn to Reader Service card, circle No. 19

CEP'S DATA SERVICE—Subject guide to free technical literature

CIRCLE CORRESPONDING NUMBERS ON DATA SERVICE CARD

EQUIPMENT *from page 108*

317 Drier, bench scale. Description and specification data for small rotary drier from Bench Scale Equip. Co.

318 Dryers. Sixteen-page Catalog of complete line of drying equipment for industry offered by Procter & Schwartz Inc.

319 Dust Control. Bulletin from Dracco Div. of Fuller discusses control of hot, corrosive dust.

320 Equipment, glass. Bulletin including industrial-type glassware from George K. Porter, Inc.

321 Evaporators. New 28-page Bulletin describes design and function of single and multiple effect evaporators. Chicago Bridge & Iron Co.

322 Extractors, liquid-liquid. Bulletin shows complete line of Lurgi-Westfalia extractors from Centrico, Inc.

323 Filter, continuous vacuum. Bulletin describes endless belt-type filter from Komline-Sanderson Eng. Corp.

324 Flow meters, electrical. Technical Brochure from Republic Flow Meters Co. discusses theory and application of remote-reading, electrical flow meters.

325 Fluid Drives, adjustable. Bulletin discusses operation and application of Gyrol fluid drive system from American-Standard.

326 Gas Turbine. New Cooper-Bessemer Brochure describes concept, characteristics, efficiency of the 10,500 h.p. gas turbine.

327 Gaskets, tantalum shielded. Information concerning shielded gaskets for corrosive service from Pfaudler.

328 Generators, nitrogen. New Bulletin describes line of packaged N_2 generators from Gas Atmospheres.

329 Heat Exchangers. Catalog discusses selection of heat exchangers and gives data for equipment from Young Radiator Co.

330 Hose, pressure. New 22-page Catalog from Imperial Brass Mfg. Co. has data on high pressure hose and accessories.

331 Hydraulic Equipment. Catalog No. 58 contains complete list of equipment from Racine Hydraulics & Machinery, Inc.

332 Hydrocarbon Handling. New 35-page Manual from Petro-Tex covers handling of pressurized liquid hydrocarbons.

333 Instruments. General 16-page Catalog describes instruments from Consolidated Electrodynamics Corp. for laboratory analysis, process control, research.

334 Laboratory Apparatus. New 344-page Catalog of laboratory apparatus from Fischer & Porter.

335 Meter, slow-flow. Information for metering unit to handle fluids to 10 gal./hr. at pressures from 2 to 40 lb. Power Plus Corp.

336 Mill, vibrating. Information from Allis-Chalmers describes 30-in. mill for continuous processing.

337 Mixing, drum. Twelve-page Bulletin from U. S. Stoneware Co. describes complete line of drum mixing equipment.

338 O-Rings. A 24-page design and data Handbook on Viton O-Rings available from Parker Seal Co.

339 Pipe Fittings. Catalog from Catawissa Valve & Fittings Co. describes gasketless cup-orifice unions and ductile iron check valves.

340 Process Equipment. Twenty-page Catalog lists solids processing equipment and systems from Sprout-Waldron.

341 Pumps, metering. Bulletin 659 describes stainless steel metering pumps from Mechanical Products Corp.

342 Reactors, solids-contact. A 20-page Bulletin from Cochrane Corp. describes reactors for water clarifying and softening.

343 Scale Models. Catalog of polystyrene scale model industrial equipment from Industrial Model Supplies, Inc.

344 Shock Absorber. Bulletin 303 from Pulsation Controls Corp. describes spherical shock trap for water lines.

345 Speed Reducers. New 66-page worm gear speed reducer Book 2824 available from Link-Belt.

346 Strainers. New 88-page Handbook for selection and sizing of strainers also contains pressure drop, viscosity, temperature data. Tate Engineering.

347 Supports, piping. New 96-page Book covers complete field of equipment supports using standard components. Details from Bergen Pipesupport Corp.

348 Trap Strainers. Seven Case Studies discuss applications of Multi-Metal Wire Cloth's trap strainers.

349 Tube Fittings. A 118-page Catalog from Lenz Co. describes complete line of tube fittings.

350 Tubing, seamless. Catalog describes fabrication service for seamless tubing from Uniform Tubes, Inc.

351 Tubing, titanium. Details for handling corrosive sodium hypochlorite solution in heat exchangers from Republic Steel Corp.

352 Turbine Impeller. Features of alternating pitch turbine impeller for liquid agitation offered by Desco Eng. Co.

353 Valves. Revised 16-page Catalog variety of valves and accessories from American Chain & Cable Co.

354 Valves, eccentric. New Bulletin contains technical data for DeZurik Corporation's eccentric valve.

355 Valves, pressure reducing. Bulletin on liquid pressure reducing valves offered by Leslie Co.

356 Valves, safety. A 24-page Technical Catalog from J. E. Lonergan Co. lists line of safety-relief valves.

MATERIALS *from page 108*

367 Plastics, molded products. Bulletin from Formica Corp. of American Cyanamid outlines complete molded products services.

368 Plastics, products. A 64-page Catalog lists end products available from wide variety of plastics. Commercial Plastics & Supply Corp.

369 Polyethylene, powdered. Technical Data from U. S. Industrial Chemicals presents applications for finely divided polyethylene.

370 Porcelain. A 26-page Catalog covers the applications of porcelain in process industries. Info from Lapp Insulator Co.

371 Precious Metals. Brochure from Texas Instrument gives industrial applications of solid and clad gold, silver, platinum-group metals.

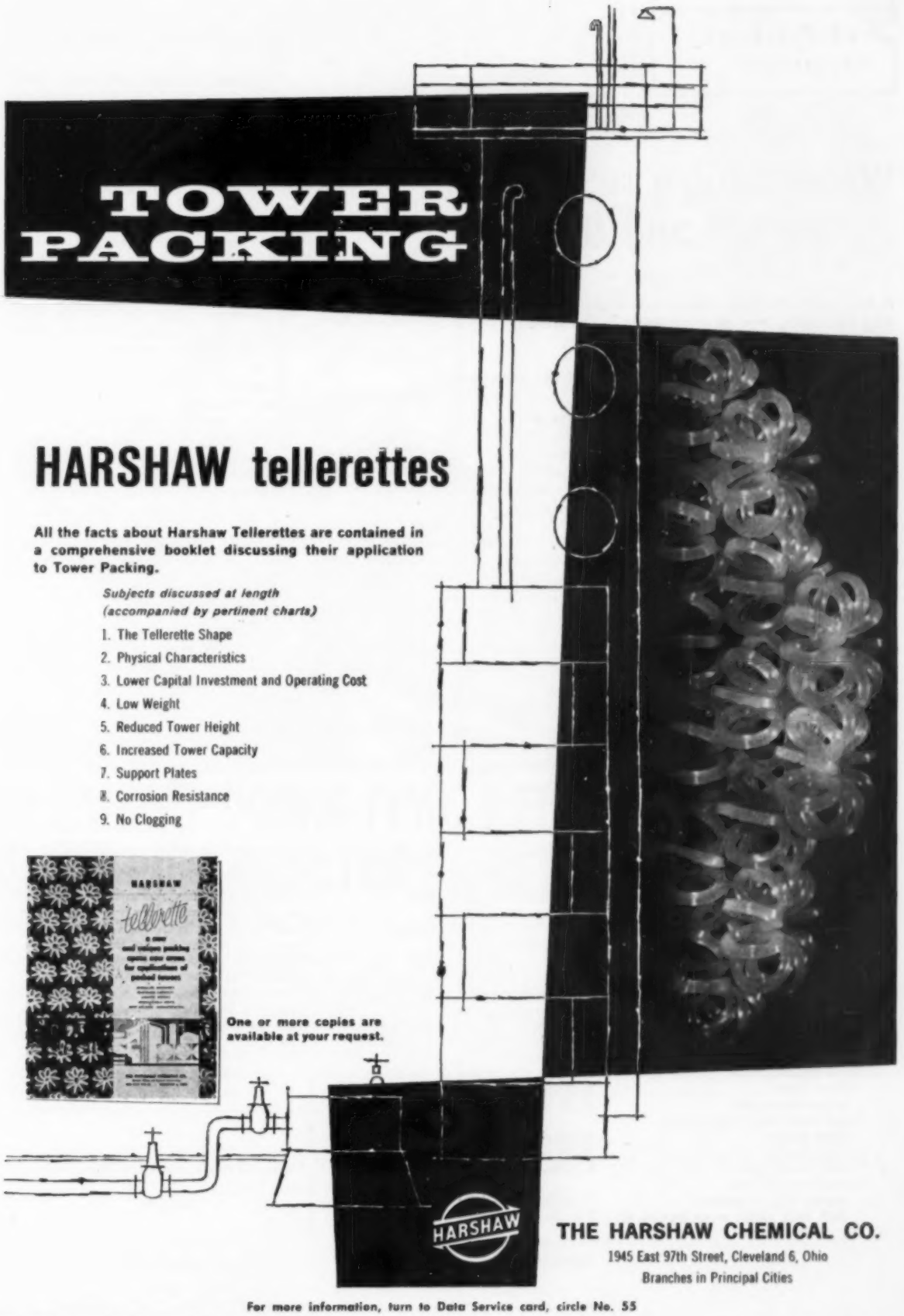
372 Rare Earths. New Brochure from Vitro Chemical Co. contains technical data on the rare earth group of elements.

373 Resins, ion exchange. Information concerning new polymeric structure of exchange resins from Rohm & Haas Co.

A.I.Ch.E. Membership

Brochure—"Know Your Institute"—tells objective aim and benefits to chemical engineers who join this nation-wide organization, includes membership blank. Circle number 600 on Data Post Card.

TOWER PACKING



HARSHAW tellerettes

All the facts about Harshaw Tellerettes are contained in a comprehensive booklet discussing their application to Tower Packing.

Subjects discussed at length (accompanied by pertinent charts)

1. The Tellerette Shape
2. Physical Characteristics
3. Lower Capital Investment and Operating Cost
4. Low Weight
5. Reduced Tower Height
6. Increased Tower Capacity
7. Support Plates
8. Corrosion Resistance
9. No Clogging

One or more copies are available at your request.

HARSHAW

THE HARSHAW CHEMICAL CO.
1945 East 97th Street, Cleveland 6, Ohio
Branches in Principal Cities

For more information, turn to Data Service card, circle No. 55

chemical feature

Water-soluble resins —the old and the new

Hydrophilic synthetic fiber made of polyvinyl alcohol may be among new developments in the field.

TOTAL U. S. MARKET FOR water-soluble resins of all types is somewhere in the neighborhood of 3 billion pounds per year. Of this total, about 2.5 billion pounds are represented by starch and its derivatives. The proteins—glue, casein, gelatin—are in the range of 250 million pounds annually, while the synthetics are variously estimated at from 75 to 100 million pounds. Remainder of the total is made up by a variety of natural gums, mostly imported. Table 1 gives an approximate breakdown of production in the various categories of natural and synthetic resins, order-of-magnitude price ranges, and main applications.

Steady growth rate

About half of the total water-soluble resin market today is in the paper industry—some 1.5 billion pounds annually. Textile uses are estimated at about 400 million pounds, food uses at around 300 million.

The paper industry is growing at a rate of about 10% per year. The food and textile industries are also geared to a rising population curve. The market for water-soluble resins, therefore, can be expected to maintain a steady, if not sensational, growth rate.

The synthetics, despite the wide price differential, are expected to grow at a somewhat faster rate than starch.

Polyvinyl alcohol front and center

Capacity for polyvinyl alcohol is presently estimated at approximately 25 million pounds per year. Of this, about 20 million are probably accounted for by Du Pont and Air Reduction, the two biggest producers. However, this year may well see a dramatic spurt in PVA. Borden is said to be getting ready to put on stream a new plant to convert the resin into cold-water-soluble film for packaging applications (tradename: Lemoflex). Capacity will be somewhere in the range of 8-10 million pounds of PVA annually.

In what may possibly presage a major breakthrough in the textile field, Air Reduction is reported to have under wraps a process for making a hydrophilic fiber out of polyvinyl alcohol, is said to be proceeding with plans for a 20-million pound-per-year plant. Such a fiber, in contrast to present-day synthetics such as Nylon, Dacron, Orlon, would absorb moisture in the manner of cotton, might prove to have great advantages for clothing applications.

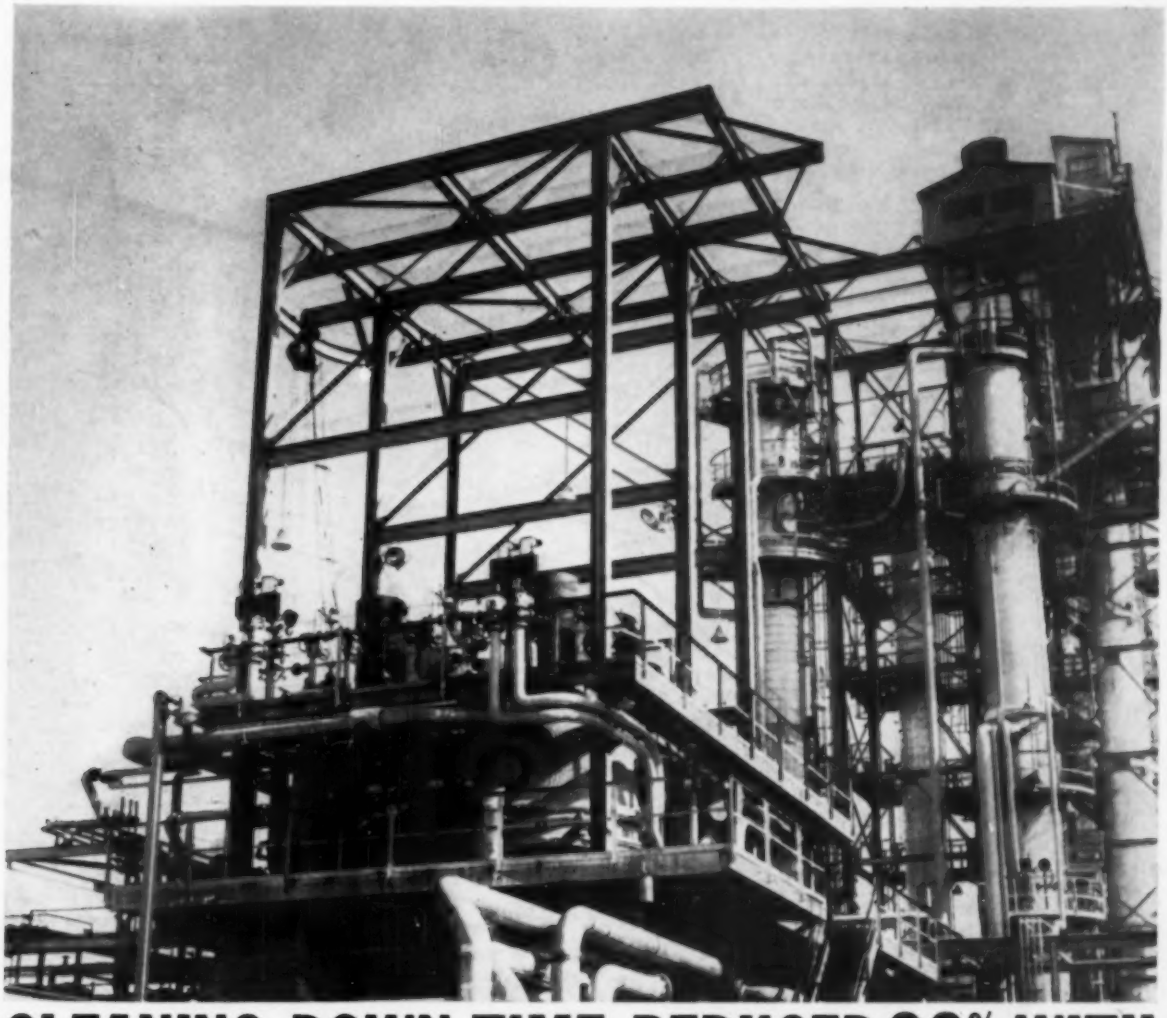
Water-soluble films

Main competitor of polyvinyl alcohol in the water-soluble film race is

continued on page 117

Table 1

WATER-SOLUBLE RESIN	APPROXIMATE ANNUAL PRODUCTION (LBS.)	APPROXIMATE PRICE RANGE (LB.)	MAIN USES
Starch & derivatives	2.5 billion	6-7¢	Paper, textiles, foods
Proteins (glue, casein, gelatin)	250 million	15-75¢	Adhesives, food, pigment binders, paper coatings
Synthetics			
Carboxymethylcellulose (CMC)	35 million	40-55¢	Soil-suspending agents in detergents, oil well drilling mud additives, textile sizes, ice cream stabilizers, homogenized tobacco leaf
Polyvinyl alcohol	25 million	80¢	Water-soluble films, adhesives, paper sizes and coatings, textile sizes
Methyl cellulose	15-20 million	60-80¢	Paper sizes and coatings, homogenized tobacco leaf, thickeners for latex paints
Hydroxyethylcellulose		84¢	Paper sizes and coatings, textile sizes, thickeners for latex paints
Polyethylene oxide	Not available	85¢	Water-soluble films, textile sizes, adhesives, high-gloss latex paints, coagulants
Polyacrylic acids	3 million	75¢-$1.00	Sizes for polyester and polyamide yarns
Polyvinylpyrrolidone	2 million	$1.00-$1.25	Hair sprays
Natural gums			
From legume seeds			
Guar gums	15-20 million	30-40¢	Sizings and coatings for paper industry, stabilizers in foods, cosmetics, pharmaceuticals
Locust bean gum	15-20 million	30-40¢	
Gums from trees and shrubs			
Gum arabic	15-20 million	20-30¢	
Gum karaya	15-20 million	30-40¢	
Gum tragacanth	2 million	$1.00	
Gums from the sea			
Brown kelp (alginates)	10 million	75¢-$1.25	
Red kelp (Irish moss extract or carogeenin)	5 million	75¢-$1.00	
Total	approx.—3 billion		



CLEANING DOWN-TIME REDUCED 69% WITH ALUMINUM REACTORS by GENERAL AMERICAN

How W. R. Grace urea plant in Memphis, Tennessee cuts cost with four 6,750 gallon General American aluminum reactors

Before designing these units, General American studied the Turbo-Gas-Absorber in a pilot operation 1/65th the size of the needed capacity. Here they determined the maximum efficiency in absorption, reaction rate and heat transfer within the reactor.

In addition, General American developed a special mixer shaft with external bearings—reducing crystal accumulation and wear within the reactor.

Result—the full size reactors are even more efficient than the pilot operation indicated. The interval between cleaning has been lengthened from 14 days to 45 days . . . a 69% reduction.

If you require process equipment, General American engineers will be glad to give technical assistance. You can pre-determine results at our complete East Chicago pilot plant. For complete information, call or write. You'll find *it pays to plan with General American.*

Process Equipment Division—Turbo-Mixer

GENERAL AMERICAN TRANSPORTATION CORPORATION

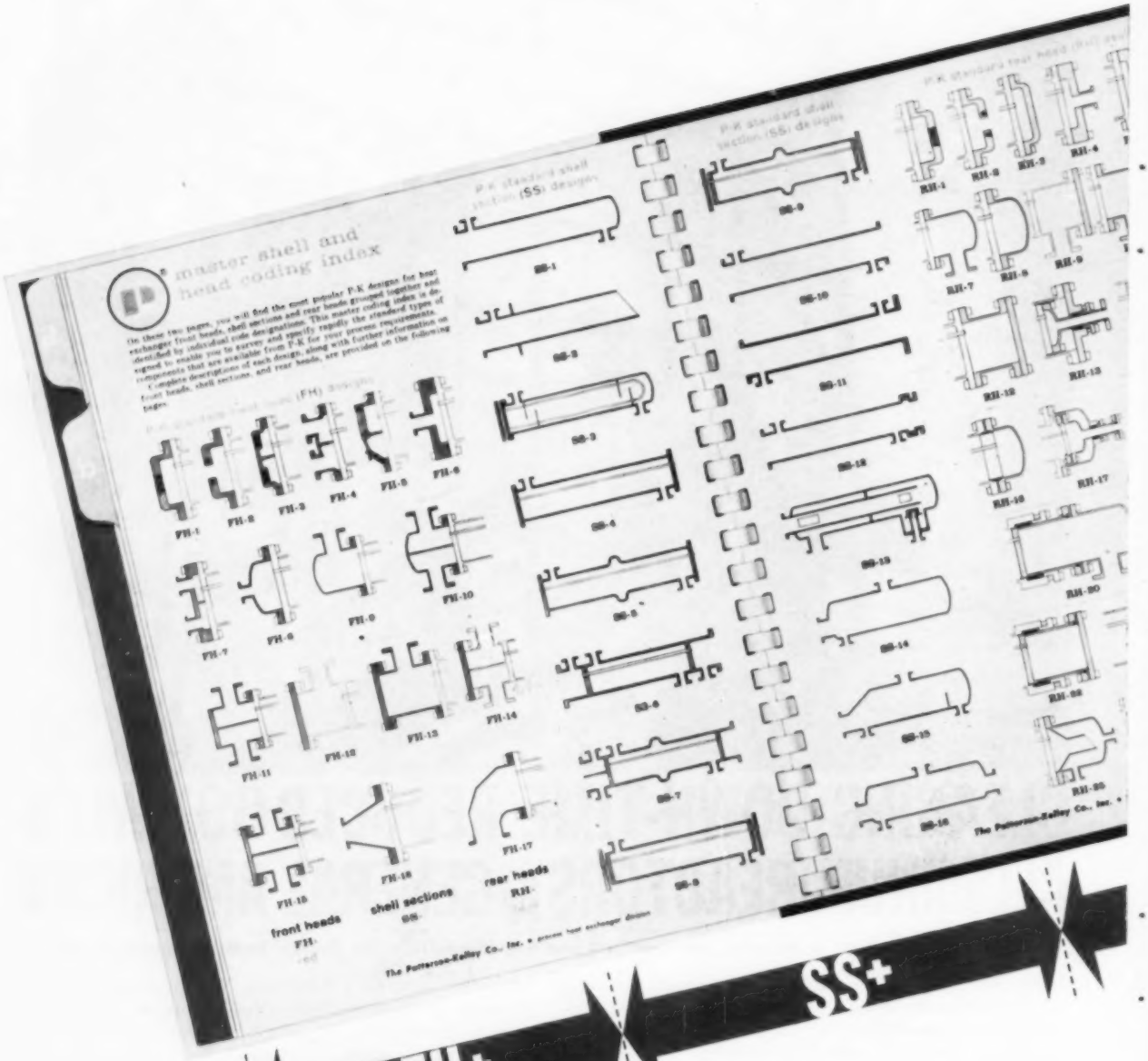
135 South LaSalle Street
Chicago 3, Illinois

TURBO-MIXER GENERAL AMERICAN

TRADE MARK

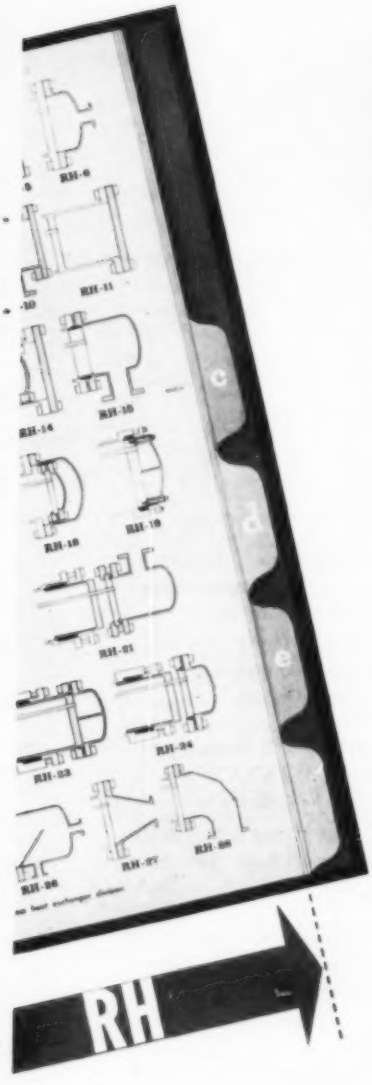
Offices in principal cities

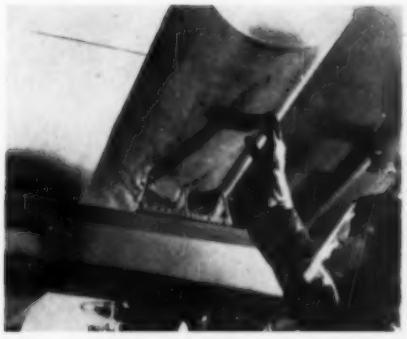
For more information, turn to Data Service card, circle No. 126



FH+ SS+

NEW SIMPLE FORMULA IN P-K HEAT EXCHANGER





AEC using P-K Heat Exchanger. This P-K Heat Exchanger runs 24 hours a day, 5 to 7 days a week, at the Uranium Processing Plant at Weldon Spring, Mo., operated for the AEC by Mallinckrodt Chemical Works. Although placed in operation in April 1958, and handling highly corrosive hydrofluoric acid at temperatures above 300°F., this two-pass shell and tube type unit has never once required maintenance.

Select the *Front Head* you want, from the *FH* group. Add the *Shell Section* you want, from the *SS* group. Add the *Rear Head* you want, from the *RH* group.

Follow these three simple steps and the formula above enables you to select the "designed" heat exchanger that meets your requirements.

As you can see, the two pages at left from the new P-K Heat Exchanger Manual provide a master coding index. This makes it possible to rapidly survey and specify the standard interchangeable components available from P-K. Succeeding pages treat design features of each component in detail and save you time when you want to determine their suitability for your application.

Suppose, for example you want an exchanger with the following: front head bonnet, multi-pass, radial flanged connections; shell section with straight tube floating head, and pull through removable bundle construction; straight tube floating rear head, pull through removable bundle and shell cover plate, with multiple pass. Consult your P-K Manual, pages b-1 through b-18. Then specify FH-10+SS-10+RH-14.

Clear, parallel picturization of standard gasket joints, tube pass partitions, shell baffles and other components simplifies the underlying details of designs.

Other sections of the manual standardize terminology, review fundamentals of heat transfer and design, even discuss economic considerations.

Since available copies of the new P-K Heat Exchanger Manual are limited in number, they are reserved primarily for those in the process industries who can most profitably use the information. If you design or specify heat exchangers, write us on your company letterhead, outlining briefly the areas of your interest. A few copies are available to students and non-technical personnel at a nominal charge. The Patterson-Kelley Co., Inc., 115 Burson Street, East Stroudsburg, Pa.

MANUAL HELPS YOU SELECT YOUR HEAT EXCHANGER

Patterson Kelley
Heat Exchanger Division

One of a series

Higher Education for Computers

"Let's put the computer in at the start of a problem, rather than just having it buzz through the computations."

This is the approach being taken by computer specialists at the General Motors Research Laboratories as they explore ways of giving large-scale digital computers a greater role in the solution of problems. The object is to "teach" computers to apply the same rules men use in formulating, analyzing, and solving questions of modern science and engineering.

A recent outgrowth of this work is DYANA, GM Research's new automatic analysis and programming system. DYANA is one of the first computer systems to "understand" declarative statements. For a large class of dynamic problems, the engineer can simply describe his physical system to the computer. The computer figures out how to handle it.

For the solution, DYANA automatically directs the computer to prepare a mathematical model of the system, to write its own program for solving the model, then to execute the program and compute the desired answers.

The higher education of computers currently involves studies in symbol manipulation, problem-oriented languages, character and pattern recognition, and engineering simulation.

Such advanced computer concepts are giving General Motors professional people more time for creative engineering and research—time to explore ideas and to develop "more and better things for more people."

General Motors Research Laboratories

Warren, Michigan

Comparison of program tapes for a vibrational problem expressed in DYANA language, in algebraic-oriented language, and in the basic machine language.

For more information, turn to Data Service card, circle No. 13

Water soluble resins

from page 112

polyethylene oxide, being marketed by Union Carbide Chemicals as "Polyox." According to Carbide, this is the only thermoplastic water-soluble resin presently in full-scale production. Advantages claimed include ability to be molded, calendered, extruded. Decisive success factors will be price and quality, says Carbide.

New family

Hercules Powder has just announced "a new family" of water-soluble polymers, composition undisclosed. The materials, called "Ceron", are available in nonionic, anionic, and cationic forms. In solution properties, the Ceron polymers are said to have characteristics similar to those of starches. However, it is claimed that they are soluble without cooking and do not retrograde. One type, Ceron N-4S, says Hercules, can be used as a water-soluble thermoplastic to produce films which not only have quick tack and a wide range of adhesion, but which can be heat-sealed. Other types are aimed at strippable coatings, textile finishes and coatings, paper applications.

Methyl cellulose (Dow's "Methocel") and hydroxyethyl cellulose (Hercules' "Natrosol" and Union Carbide's "Cellosize") probable reckon up to somewhere between 15 to 20 million annual pounds. A new type of Cellosize, QP-4400, introduced by Union Carbide in April of this year, is claimed to go into solution as easily as sugar, and to be an efficient thickening agent with a high tolerance for electrolytes.

Trends in synthetics

Trend in the food industries is toward increased use of synthetic resins, not only for packaging, but as stabilizers in such food products as ready-to-use cake mixes, instant pizzas, etc.

The so-called "homogenized" tobacco, used in certain filter-tip cigarettes, is being produced with CMC as a binder, extruded into sheets, and then reshredded. Such "synthetic" tobacco films may soon also be used for cigar wrappers.

Starch fights back

In addition to its recently-announced all-amylopectin starch, "Kosol," National Starch and Chemical is marketing evaluation quantities of a new

continued on page 118

NEW
PNEUMATIC TRANSMITTING ROTAMETER
offers
"NEVER-BEFORE"
features
PERCENT FLOW
Simplified drawing shows how Transmitter and Rotameter are coupled magnetically. As encapsulated magnet in float extension rod moves vertically up or down, follower magnets in arm follow movement. Magnet arm operates ball pilot in Transmitter Unit which controls air pressure for accurate transmission of rates of flow.
ARM WITH FOLLOWER MAGNETS
LINEAR ADJ. DIAL
MAGNET
EXTENSION ROD
TUBE
FLOAT
PILOT STEM
TRANSMITTER UNIT

SK Model 58 Pneumatic Transmitter with SK Safeguard Rotameter.

Here's a new design in Pneumatic Transmitters—the Model 58 by SK's INSTRUMENT DIVISION. Designed for use with either SK Safeguard or Metal Tube Rotameters, these "position-balance" type transmitters communicate fluid rates of flow to remote located indicators, recorders, controllers, or integrators. Here are some of many important advantages offered by the Model 58.

- Calibration adjustments are simple without cams, special devices.
- Exclusive magnet design (patent applied for) provides evenly-distributed field without drag on metering float.
- Transmitter Unit of pneumatically-coupled section design has no mechanical linkages, assures high accuracy.
- Percent scale suitable for any calibration. Factor tag on dial face permits conversion of scale units to flow quantity.
- Varying supply air pressure (between 20 and 25 psig) will not affect accuracy.
- Large scale and pointer permit easy, accurate reading.
- Removal of transmitter not required for cleaning main valve or pilot orifice.

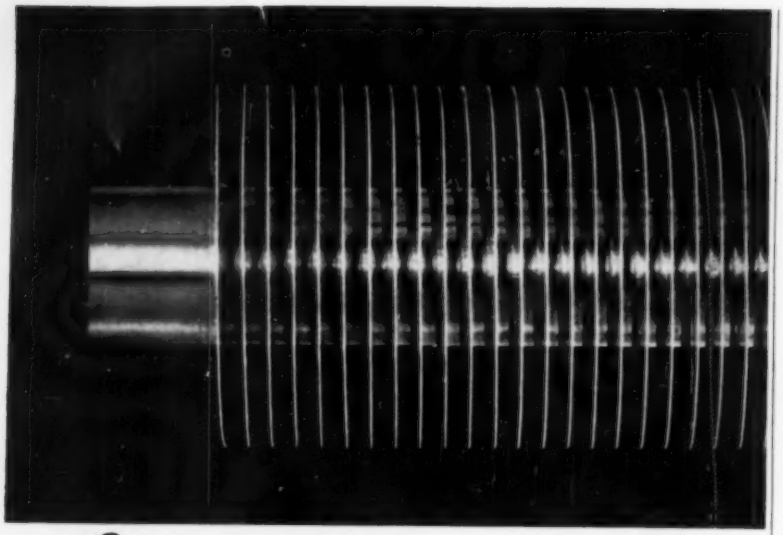
Details on this new Transmitter are covered in Bulletin 18N which is available on request.

QUICK DELIVERY FROM STOCK

For Immediate Delivery, Standard SK Jet Ejectors, Rotameters, and Flow Indicators are stocked in Cornwells Heights (Phila.), Pa., Houston, Texas, and San Francisco, Calif.

Schutte and Koerting COMPANY
INSTRUMENT DIVISION
2245 STATE ROAD, CORNWELLS HEIGHTS, BUCKS COUNTY, PA.

For more information, turn to Data Service card, circle No. 46



AEROFIN
Smooth-Fin Coils
offer you

Greater Heat Transfer
per sq. ft. of face area

Lower Airway Resistance
—less power per c.f.m.

Aerofin smooth fins can be spaced as closely as 14 per inch with low air friction. Consequently, the heat-exchange capacity per square foot of face area is extremely high, and the use of high air velocities entirely practical. Tapered fin construction provides ample tube-contact surface so that the entire fin becomes effective transfer surface. Standardized encased units arranged for simple, quick, economical installation.

AEROFIN CORPORATION

101 Greenway Ave., Syracuse 3, N. Y.

Write for Bulletin S-55

Aerofin is sold only by manufacturers of fan system apparatus. List on request.

For more information, turn to Data Service card, circle No. 2

Water soluble resins

from page 117

high-amylose starch which, claims National, will form much more water-resistant films than ordinary starch products. The new starch, however, must be cooked at higher than usual temperatures and pressures to get it properly into solution.

New Engineering Index

THE ENGINEERING INDEX, 1959 edition, was published in June. The Annual bound volume contains annotations on over 30,000 articles in 249 fields of engineering interest. In the reference book are publications of engineering, scientific and technical societies, industrial periodicals, and publications of government bureaus, engineering experiment stations, universities and other research organizations. Over 100 pages are devoted to an authors list covering more than 1500 technical journals. Available from: Engineering Index, Inc., 29 West 39th Street, N.Y. 18. N.Y.

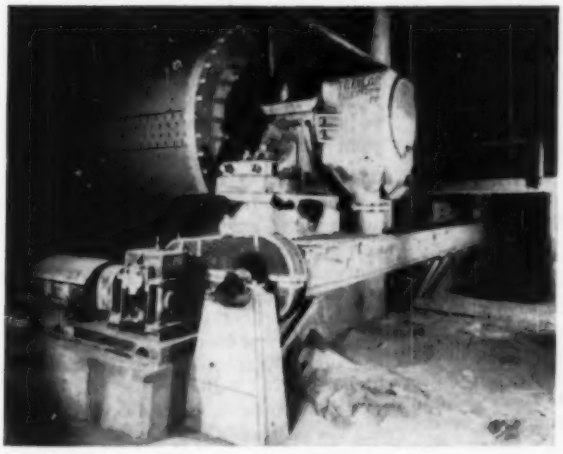
NUCLEAR CONGRESS PAPERS. Papers presented at the 1960 Nuclear Congress are now available. Forty-nine of the total of sixty-two have been released for publication, and may be ordered as a complete set for $20 or individually by number, for 50¢. Orders and inquiries should be addressed to: The 1960 Nuclear Congress, 29 West 39th Street, New York 18, N. Y.

Contributions made to ECPD are tax deductible, according to the Treasury Department. They recently notified the Council that it is exempt from Federal Income Tax, as an organization operated exclusively for educational and scientific purposes. This revokes a 1958 ruling which held the ECPD is not entitled to exemption.

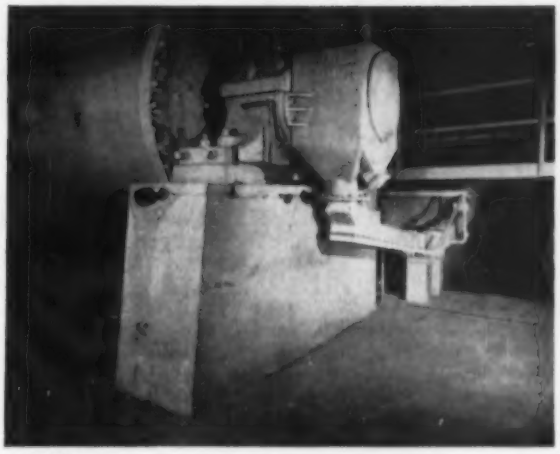
Formation of Parsons Powergas, is new joint enterprise of Ralph M. Parsons Co., Los Angeles, and P. G. Engineering, Ltd., organization of British companies. The new firm, headquartered in London, will engineer and construct petroleum, petrochemical, and related plants in the British Commonwealth.

Pittsburgh Chemical moves into production of maleic anhydride with a new plant at Neville Island. Due to go on stream in 1961, the facility will have a 20 million pounds annual capacity.

The Arithmetic of Materials Handling



BEFORE: **Dirt, noise and mechanical breakdown** were constant problems in this cement plant, where two mechanical conveyors were used to collect raw materials. A 5 h.p. motor driving auxiliary equipment wasted valuable space and power, required frequent maintenance. Spillage clean-up wasted costly man-hours.



AFTER: **Clean, simple, quiet.** Notice the difference two 8" F-H Airslide® fluidizing conveyors have made. No dangerous moving parts. Nothing to lubricate. Auxiliary equipment and foundations are gone. Power needs are now only ⅙ of previous needs. Fluidizing saves wear and maintenance.

AIRSLIDE® Fluidizing Conveyor

minimizes material loss . . . maintenance . . . moving parts

If you are now handling dry, pulverized materials, the F-H Airslide Fluidizing Conveyor can help you stop noise, and air-pollution, as well as speed flow and reduce maintenance cost.

Simplicity Itself

F-H Airslide conveyors fluidize dry, pulverized materials with low pressure air.

These materials literally flow at high speed, down the inclined conveyor. Power requirements are small.

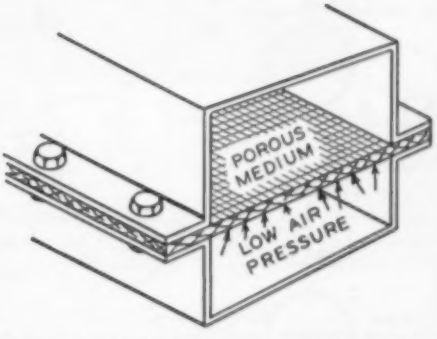
Flexibility, Low Cost

For unlimited applications, Airslide conveyors take up little space, and can be used singly and in combination with other Fuller pneumatic conveying systems. The movement of fluidized material can be around corners, between floors, through walls—nearly any conveying distance.

Better Housekeeping

Can Fuller conveying systems help eliminate your housekeeping problems—cut your maintenance and handling costs? Write today, outlining your problem in handling dry, finely-divided materials. Fuller will gladly make appropriate recommendations.

"Pulverized Materials Flow Like Water!"



FLUIDIZING PRINCIPLE: Porous supporting medium divides conveyor section into two "compartments". Dry material flows down inclined conveyor, fluidized by low-pressure air entering beneath porous medium.

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industrial focus

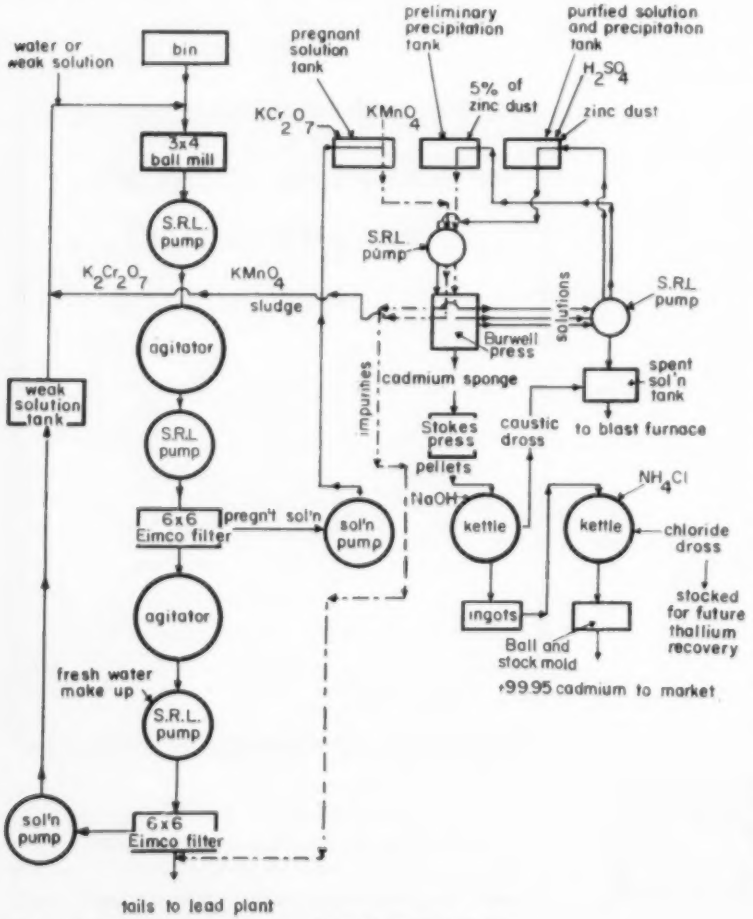
F. W. Gibson, *Cia. Metalurgica Penoles, Coahuila, Mexico*

New twist in cadmium production

Process developed at Mexican lead smelter avoids concentration of cadmium in furnaces, reagent addition

Incoming ores and concentrates at the lead smelter of Cia. Metalurgica Penoles, Torreon, Coahuila, Mexico, carry small amounts of cadmium, varying from traces to about 0.05%. Intake in recent years has varied from 3 to 6 tons per month.

Cadmium, being extremely volatile, is collected in the blast furnace fume. At Torreon these fumes were formerly circulated back through the sinter plant and blast furnaces to enrich the cadmium content. As the blast furnace fume was collected in a Cottrell instead of baghouses, there were losses with each recirculation of the fume. Experience has shown that there were excessive losses if the fume was concentrated over 10% cadmium. Therefore, Torreon practice was to concentrate the cadmium in the Cottrell fume up to 8 to 10%, densify the fume in a Godfrey roaster, and ship the densified dust out of the plant for further treatment.



The Cadmium Plant flow sheet of the Torreon Smelter.

Cadmium plant studies

With the idea of reducing the cadmium losses, studies were started several years ago to determine the feasibility of a cadmium plant at Torreon.

After considerable research and small pilot plant tests, it was found that the cadmium could be extracted economically from a dust containing as low as 5% Cd by pugging the dust with concentrated sulfuric acid, roasting the mixture in the Godfrey roaster at about 500°C and then leaching the sulfated roast with water. The cadmium was then precipitated from the pregnant solution by means of zinc dust.

However, shortly after these tests had been completed, it was noticed that the Cottrell dust contained considerable chlorine, and it was decided to experiment with the possibility of extracting the cadmium as a chloride rather than a sulfate.

The Cottrell dust in its natural state showed little water soluble cadmium, indicating that the cadmium was probably in the form of CdO, while any chlorine present was in the form of $PbCl_2$ and $ZnCl_2$. Laboratory tests showed that, upon heating above 325°C, up to 80% of the cadmium became water soluble. After considerable testing, it was decided to construct a plant for extraction and production of cadmium based on leaching of soluble cadmium chloride and precipitation of cadmium metal from the pregnant solution by means of zinc dust.

The process differs from most cadmium extraction processes in that no attempt is made to concentrate the cadmium in the furnaces and no reagents are added to the dust for conversion of cadmium oxide to produce a water soluble cadmium compound.

Densification

Present practice at Torreon involves densification of the Cottrell dust in a Godfrey furnace at 400°C to convert CdO to $CdCl_2$. Residence time is 6 to 8 hours. To avoid excessive cadmium volatilization, the draft at the roaster outlet is maintained as low as possible, usually about 1.5 mm.

Theoretically, if all the chlorine

were to combine with the cadmium, the maximum permissible ratio of Cd to Cl would be 1.6:1 in the densified material in order to obtain maximum extraction. However, in actual practice, there is some chlorine volatilization loss, as well as the probability that not all of the chlorine is in the form of zinc chloride in the Cottrell dust. Experience at Torreon has shown that a Cd:Cl ratio of 1:1 is required before densifying in order to obtain 66 to 70% soluble chlorine in the densified product. To assure sufficient chlorine in the Cottrell dust, small amounts of chlorine-bearing secondaries are added directly to the blast furnace charge. Also, the neutralized spent solution from the cadmium plant, containing 20-25 grams/liter $ZnCl_2$, is sprayed on top of the blast furnace charge.

Grinding, leaching, filtering

The densified dust is fed into a 4′ x 4′ ball mill where it is pulped with weak solution from the second filter. Mill product contains 80% 325 mesh. The pulp averages 60% solids with a pulp density of 2.3 to 2.5. The pulp is then transferred to a 4′ x 4′ Denver agitator for further leaching. Overflow from the agitator goes to a 6′ x 6′ Eimco drum filter. Filtrate containing 70-80 grams/liter cadmium is passed to the pregnant solution tank, and the leached cake is discharged into another 4′ x 4′ agitator for repulping with fresh water.

Water is added at the second agitator to make a pulp of 55% solids which is pumped to a second 6′ x 6′ Eimco filter. Filtrate from this second filter goes to the weak solution storage tank for feed to the ball mill, while the filter cake is returned to the smelting circuit.

This second filtration is actually a wash operation for removal of as much soluble cadmium as possible. The moisture content of the cake averages 15-17%, and soluble cadmium in the cake rarely exceeds 0.5%.

Handling the pregnant solution

The pH of the solution is checked and, if necessary, adjusted to a range of 5.0 to 5.5 with soda ash. Potassium dichromate is then added for lead removal. Following settling and decantation, the solution is treated with potassium permanganate for removal of arsenic.

The partially purified solution is then subjected to a preliminary precipitation operation with a small amount of zinc dust for copper removal. The amount of zinc dust added to remove copper is about 4% of

continued on page 122

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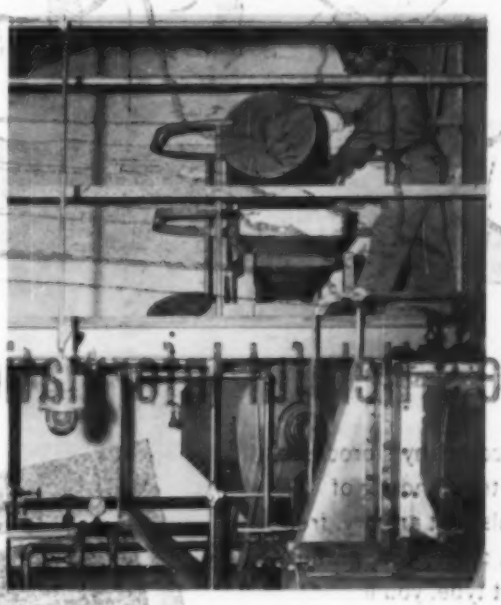

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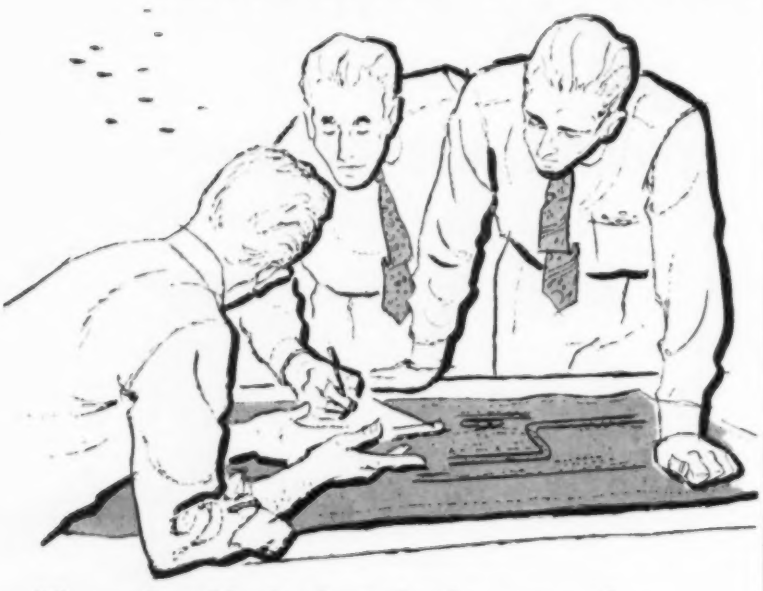

Here's Helpful Information

If your company's processes involve the handling of materials that are dry, free flowing, pulverized, granular or pellet type, you'll find this bulletin interesting and informative. It describes SPENCER pneumatic conveying systems (stationary and portable) . . . contains diagrams of typical systems . . . illustrates representative applications . . . itemizes the advantages of conveying pneumatically.

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For more information, turn to Data Service card, circle No. 38

Cadmium production

from page 121

the total zinc dust required for complete precipitation of cadmium. Purified solution and copper-bearing sponge are then passed through the filter press, the solution going to a storage tank, while the impure sponge is thrown into the cake discharge from the second drum filter for return to the smelting circuit.

Cadmium precipitation

The cadmium precipitation operation is carried out in batches of 3,000 liters to each of which sulfuric acid has been added to give a free acid content of 4 grams/liter. Ninety percent of the required zinc dust is added during agitation. The cadmium sponge forms immediately, and is agitated continually for about two hours or until the sponge forms into porous metallic balls about ¼ in. in diameter.

Once these balls are formed, the tank contents are pumped to an Eimco Burwell filter press. Filtered solution goes to the second precipitation tank to be stripped of all remaining cadmium. The cadmium sponge is washed with water until the wash water shows no trace of cadmium. It is then briquetted into disks 2 in. in diameter and ¾ in. thick and stored under water to prevent oxidation.

Melting

The briquettes are melted under a bath of molten caustic in a small oil-fired kettle. The molten caustic not only acts as a cover to prevent oxidation of the cadmium during melting, but also absorbs any zinc that might be present. Caustic requirements are 6 kg. per 100 kg. of cadmium. Once the melt is fluid, the cadmium is tapped off into 30 kg. ingots which are remelted in another kettle and treated with ammonium chloride for removal of thallium.

Typical analysis of Torreon cadmium is:

Cadmium	99.95+%
Lead	0.015%
Arsenic	0.0001%
Copper	0.0008%
Zinc	0.001%
Thallium	0.002%

Now on stream is the 50 million pound a year polyvinyl chloride homopolymer and copolymer resins plant of Cary Chemicals, at Flemington, N. J. The company has also expanded its compounding facilities at East Brunswick, N. J. to a 36 million pound capacity.

New oxygen plant on stream at Linde

1000 ton a day facility, part of $50 million expansion program, will bring on-site oxygen production to an estimated 20% of total U.S. capacity.

A NEW OXYGEN PRODUCING facility built by Linde, on stream at the Duquesne Works of U.S. Steel, is said to be one of the largest on-site plants ever built for the steel industry. The 1000 ton a day plant will serve three other U.S. Steel facilities in the Pittsburgh area through an interurban pipeline.

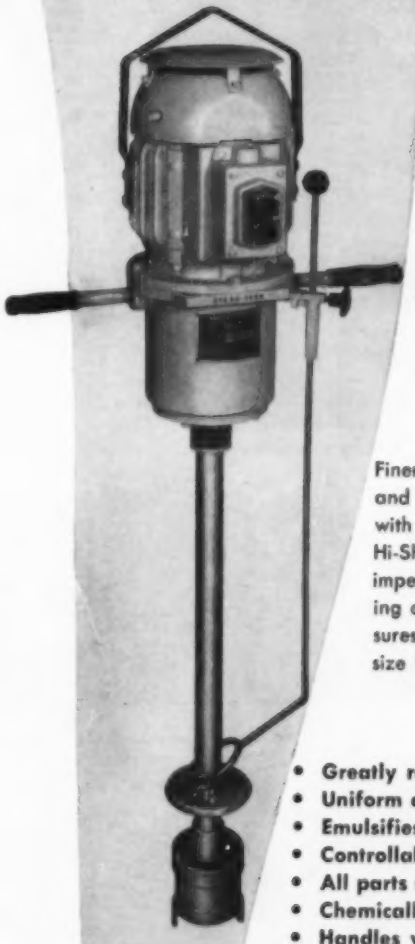
An increase of 4000 tons a day in the oxygen producing capacity of Linde will result from presently scheduled expansion of facilities at sixteen locations throughout the country. Backed by the constantly increasing demand for oxygen, the current company program includes about $50 million in new on-site plants to produce gaseous oxygen. This is an estimated 20 percent of the total presently installed U.S. production capacity for oxygen. Most of this will serve steel producers, although some of the on-site plants can be considered as sources for argon production. Modifications in equipment can permit substantial additional volumes of argon to be produced.

Other new Linde plants now being built according to specific customer estimates of requirements are: at Gadsen, Alabama, 85 tons a day capacity; Pueblo, Colorado, 280; Chicago, Ill., Portsmouth and Middletown, Ohio, and Morrisville, Pa. 140 each; Charleston, West Va. 85; Cincinnati, Ohio, 30; Buffalo, N.Y. 320; Detroit, Mich. 500; Gary, Indiana, 135; Cleveland, Ohio, 280. #

Anhydrous ammonia and urea will be produced at a unit to be built by Atlas Powder and Standard Oil (Ohio's) jointly owned company, Solar Nitrogen Chemicals. The ammonia unit, scheduled for completion in about one year, is located near Joplin, Mo.

A new unit manufacturing acetanilide technical at Chemetron's Newport, Tenn. plant, will supply company needs as well as the market.

SHEAR-FLOW



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For more information, turn to Data Service card, circle No. 53

meeting preview

Happenings in heat transfer world

Fourth Annual National Conference and Exhibit in Buffalo, N.Y., August 14-17 will spotlight latest developments in heat transfer field; jointly sponsored by A.I.Ch.E. and ASME.

ONCE AGAIN, HEAT TRANSFER will be spotlighted in the engineering world when the Fourth Annual Heat Transfer Conference is held this summer. The National Conference and Exhibit, expected to be a record breaker, will present the newest and best developments in the fast growing and rapidly changing heat transfer field. Host city is Buffalo, N.Y., in the heart of a major chemical process industry area. Sponsored jointly by A.I.Ch.E. and ASME Heat Transfer Divisions, the meeting will take place August 14-17 at the Statler Hotel.

Industry interest in the Exhibit has been steadily growing. To be held in conjunction with the technical sessions, it is shaping up as an outstanding showing of heat transfer equipment. More on this in next month's CEP, when a list of exhibitors will appear.

While the meeting does take place in August, our informants in the Weather Bureau tell us that temperature-wise, Buffalo's average runs about 68.9°, and it may drop lower.

Special events

A well rounded picture of the area is presented by the tours arranged as part of the program. They range from a trip through the Albright Art Gallery, to the major industrial plants. Trips to Niagara Falls and the Niagara Power Project are highlights. This largest hydroelectric development in the Western world will be

The heart of downtown Buffalo. Right rear is the Hotel Statler which will be the headquarters hotel for the joint A.I.Ch.E. ASME Heat Transfer Conference.

Three-Day Schedule of Technical Sessions

MONDAY, AUGUST 15

9:00 A.M.-12 Noon

SESSION NO. 1. Chairman: S. W. Churchill, Univ. of Mich. (A.I.Ch.E.). Co-chairman: S. Kopp, Alco Products (ASME).

Temperature Depressions for Evaporating Spheres at Low Pressures, A. J. Madden & F. J. Halfen, Univ. of Minn.

A Design Method for the Economical Drying of Moisture from Solids, H. T. Bates, Kansas State Univ.

An Analytical Study of Laminar Film Condensation. Part 1—Flat Plates. Part 2—Single and Multiple Horizontal Tubes, M. M. Chen, MIT.

Condensing Coefficients Inside a Horizontal Tube Near Atmospheric Pressure, J. A. Myers & H. F. Rosson, Univ. of Kansas.

Heat Transfer from Humid Air to Fin-and-Tube Extended Cooling Coils, C. D. Ware and T. H. Hacha, Trane Company, LaCrosse, Wisconsin.

SESSION NO. 2. Chairman: W. E. Hammond, Air Preheater Corp. (ASME). Co-chairman: C. H. Gilmour, Union Carbide Chemicals (A.I.Ch.E.).

Some Aspects of the Melting Solution for a Semi-Infinite Slab, M. Altman, General Electric.

Efficiency of Finned Annular Passages, A. D. Kraus, Sperry Gyroscope.

On Unsteady State Heat Transfer in a Hollow Cylinder or Sphere, W. W. Clawson, Ill. Inst. of Tech.

Wall Temperature and Heat Flux Measurement in a Round Tube, A. I. Morgan, Jr. & R. A. Carlson, U. S. Dept. of Agriculture.

Temperature Regulation in a Bio-Satellite, K. L. Cappel, Franklin Inst.

9:30 A.M.

OPEN PANEL DISCUSSION NO. 1. (ASME)—HEAT TRANSFER IN ADVANCED REACTOR CONCEPTS. Moderator: P. A. Lottes, ANL.

2:00-5:00 P.M.

SESSION NO. 3. Chairman: J. G. Knudsen,

ready to go into service in February, 1961, with a total installed power of over 2 million kilowatts. The story of the project from intake at the river to delivery of electricity to consumers will be told.

Another feature of the tours will be a look at the Hooker Chemical Niagara Falls plant, where the Hooker-developed diaphragm cell for the electrolysis of salt brine can be observed. Also scheduled are trips to Carborundum's new R&D pilot plant. Du Pont's Electro-chemical Department offers a view of its facilities for producing metallic sodium. At the Cornell Aeronautical Research Lab., a color film tracing developments in the field will be shown.

Awards Luncheon

One of the features of the Conference will be the Awards Luncheon, where the heads of both sponsoring organizations will preside, Jerry McAfee as toastmaster, and Walker Cisler, ASME president, as main speaker. The award will be presented for the best paper delivered at the Third National Conference last year at Storrs, Conn.

Oregon State College (A.I.Ch.E.). Co-chairman: E. M. Sparrow, Univ. of Minnesota.

Local Radial Effective Conductivity and Wall Effect in Packed Beds, R. F. Baddour & C. Y. Yoon, MIT.

The Relation Between the Transfer Coefficients and Thermal Fluctuations in Fluidized Bed Heat Transfer, H. S. Mickley, D. F. Fairbanks & R. D. Hawthorn, MIT.

Heat Transfer with a Flowing Fluid Through Porous Media, D. W. Green & R. H. Perry, Univ. of Oklahoma.

A Review of Fluid to Particle Heat Transfer in Packed and Moving Beds, T. G. Bowers & H. Reintjes, Petrocarb.

Continuous Heat-Processing of Granular and/or Powdered Solids in Dry-State Fluidization, A. D. Holt, Jeffrey Mfg.

SESSION NO. 4. Chairman: H. A. Johnson, Univ. of Calif. (ASME). Co-chairman: R. F. Fremed, McGraw Hill Book Co. (A.I.Ch.E.).

Thermal Conductivity Studies with the Powell Method, A. I. Dahl & D. W. Jones, General Electric.

Quantitative Evaluation of Edge Losses and Contact Resistances in the Determination of Thermal Diffusivity of Solid Materials by an Unsteady State Method, A. A. Armstrong & K. O. Beatty, North Carolina State College.

The Viscosity of Steam and Water at Moderate Pressures and Temperatures, J. R. Messyasaki, Case Inst. of Tech.

Viscosity, Thermal Conductivity and Prandtl Number of Carbon Dioxide—Air Mixtures, J. L. Novotny & T. F. Irvine, Jr., Univ. of Minn.

P-V-T-Data for Water in the Critical Region. Part 1—A Survey. Part 2—Smoothed Relations Derived from the Experimental Measurements. E. S. Nowak, R. J. Grosh & P. E. Liley, Purdue Univ.

8:00 P.M.

OPEN PANEL DISCUSSION NO. 2 (A.I.Ch.E.)—DISCREPANCIES BETWEEN DESIGN PROCEDURES AND PLANT OPERATIONS. Moderator: D. Q. Kern, D. Q. Kern Associates. Panelists: D. J. Bergman, UOP; C. H. Brooks, Sun Oil; C. H. Gilmour, Union Carbide Chemicals; A. C. Mueller, Dupont.

TUESDAY, AUGUST 16

9:00 A.M.-12 Noon

SESSION NO. 5. Chairman: A. S. Foust, Lehigh Univ. (A.I.Ch.E.). Co-chairman: S. Ostrach, National Aeronautics and Space Adm. (ASME).

continued on page 126

Eaton-Dikeman filter papers help National Foam System fight fire effectively

"Fire fighting foam liquids must be free from all suspended solids to insure chemical stability and satisfactory performance in the equipment in which they are used. We believe our Aer-O-Foam fire fighting foam liquids are the *cleanest* in the world," says D. N. Meldrum, Chemical Director, National Foam System, Inc., West Chester, Pa.

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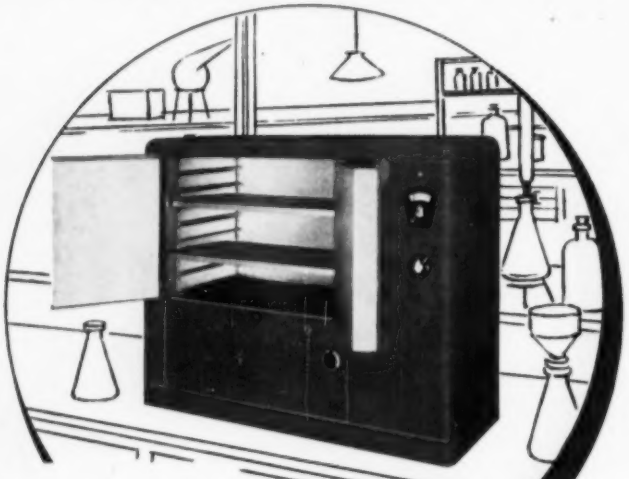

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Technical sessions

from page 125

Dimensional Analysis and Natural Convection, J. D. Hellums & S. W. Churchill, Univ. of Mich.

A Theoretical Analysis of Laminar Natural Convection Heat Transfer to Non-Newtonian Fluids, A. Acrivos, Univ. of Calif.

Transient Natural Convection from Vertical Elements, B. Gebhart, Cornell Univ.

The Influence of Sound on Free Convection from a Horizontal Cylinder, R. N. Fand & J. Kaye, MIT.

An Experimental Study of the Effects of Strong Progressive Sound Fields on Free Convection from a Horizontal Cylinder, A. L. Sprott, J. P. Holman & F. L. Durand, Wright Air Development Center.

Correlation of Convective Heat Transfer in Confined Horizontal Layers, J. L. O'Toole & P. L. Silveston, Newark College of Eng.

SESSION NO. 6. Chairman: J. F. Wachunas, Babcock and Wilcox (ASME). Co-chairman: E. H. Young, Univ. of Mich. (A.I.Ch.E.).

Fluid Friction and Heat Transfer in Cylindrical Pipes: Relationship between Lumped and Distributed Parameters, J. C. Smith, Cornell Univ.

Heat Transfer by a Turbulently Flowing Fluid-Solids Mixture in a Pipe, C. L. Tien, Univ. of Calif.

Heat Transfer to Water in Turbulent Flow in Internally Heated Annuli. Part 1—Stationary Flow. Part 2—Pulsating Flow, I. Shai & Z. Rotem, Israel Inst. of Tech.

Heat Transfer and Pressure Drop in an Annular Gap with Surface Spoilers, G. A. Kemeny & J. A. Cyphers, Westinghouse Electric.

Rates of Heat Transfer from Short Sections of an Isothermal Pipe, A. A. Faruqui & J. G. Knudsen, Oregon State College.

The Effect of Density Variation on Heat Transfer in the Critical Region, Y. Y. Hsu & J. M. Smith, Northwestern Univ.

9:30 A.M.

OPEN PANEL DISCUSSION NO. 3 (ASME)—OXIDE FUEL HEAT TRANSFER. Moderator: R. Powers, Sylvania-Corning Nuclear.

2:00-5:00 P. M.

SESSION NO. 7. Chairman: J. W. Westwater, Univ. of Ill. (A.I.Ch.E.). Co-chairman: S. Levy, General Electric (ASME).

Analysis and Interpretation of the Shape of the Boiling Curve, K. O. Beatty, North Carolina State College.

Transition Boiling Heat Transfer, P. J. Berensen, MIT.

On the Mechanism of Subcooled Nucleate Boiling. Part 1—Preliminary Considerations. Part 2—Sequential Rate Process Model, S. G. Bankoff, Northwestern Univ.

Burnout in Turbulent Flow—A Droplet Dispersion Model, K. Goldmann, H. Firstenberg, & C. Lombardi, Nuclear Development Corp. of America.

A Photographic Study of Pool Boiling in the Region of the Critical Heat Flux, R. Cole, National Aeronautics and Space Adm.

Heat Transfer, Burnout and Pressure Drop for Water in Swirl Flow Through Tubes with Internal Twisted Tapes, W. R. Gambill, R. D. Bundy, & R. W. Wansbrough, ORNL.

SESSION NO. 8. Chairman: G. M. Dusinberre, Penn. State Univ. (ASME). Co-chairman: C. H. Brooks, Sun Oil (A.I.Ch.E.).

Radiation Heat Transfer in a Spherical Enclosure Containing a Participating, Heat-Generating Gas, E. M. Sparrow, C. M. Usiskin, & H. A. Hubbard, National Aeronautical and Space Adm.

Analysis, Results and Interpretation for Radiation between Some Simply-Arranged Gray Surfaces, E. M. Sparrow, J. L. Gregg, J. V. Szel, & P. Manos, National Aeronautical and Space Adm.

Radiant Heat Transfer Analysis of a Furnace or other Combustion Enclosure, J. T. Bevans, Shell Development.

Radiant Heat Transfer. Part 1—from Flat Plate Uniformly Heated on One Edge. Part 2—from Tapered Fin with Constant Temperature Gradient, Uniformly Heated at Root Section, D. B. Mackay & E. L. Leventhal, North American Aviation.

Radiative Transport within an Ablating Body, L. P. Kadanoff, AVCO Research Labs.

Investigation of the Performance of a Shop Assembled Vaporizer Using Dowtherm, J. H. Born, Jr. & M. L. Jones, Foster Wheeler.

8:00 P.M.

OPEN PANEL DISCUSSION NO. 4 (ASME)—HEAT EXCHANGER STANDARDIZATION. Moderator: R. M. Armstrong, R. M. Armstrong Co.

WEDNESDAY, AUGUST 17

9:00 A.M.-12 Noon

SESSION NO. 9. Chairman: M. Y. Cichelli, Dupont (A.I.Ch.E.). Co-chairman: T. F. Irvine, Jr., North Carolina State College (ASME).

Heat Transfer to Laminar Flow across a Flat Plate with a Nonsteady Surface Temperature, R. D. Cess, Westinghouse Electric.

Film Cooling. Part 1—with Multiple Continuous Slots. Part 2—with Multiple Rows of Discrete Louvers, J. H. Chin, S. C. Skirvin, L. E. Hayes, & F. Burggraf, General Electric.

Velocity Distributions, Temperature Distributions, Effectiveness, and Heat Transfer for Air Injected Through a Tangential Slot into a Turbulent Boundary Layer, J. P. Harnett, R. C. Birkebak, & E. R. G. Eckert, Univ. of Minn.

Two Phase Slug Flow, P. Griffith & G. B. Wallis, MIT.

Heat Transfer and Pressure Drop in Two-Phase Flow, K. E. Lunde, Yuba Consolidated Indust.

Forced Convection Heat Transfer from an Isothermal Shpere to Water, G. C. Vliet & G. Leppert, Stanford Univ.

SESSION NO. 10. Chairman: W. M. Rohsenow, MIT (ASME). Co-chairman: D. Miller, ANL (A.I.Ch.E.).

Hydraulic Instability in a Natural Circulation Loop with Net Steam Generation at 1,000 psia, S. Levy & E. S. Beckjord, General Electric.

Analysis and Measurement of Flow Oscillations, E. R. Quandt, Westinghouse Electric.

Pool Boiling in an Accelerating System, H. Merte, Jr. & J. A. Clark, Univ. of Mich.

An Experimental Study of Boiling in Reduced and Zero Gravitational Fields, C. M. Usiskin & R. Siegel, National Aeronautics and Space Adm.

Measured Variation in Local Surface Temperatures in Pool Boiling of Water, S. T. Hsu & F. W. Schmidt, Univ. of Wis.

9:30 A.M.

OPEN PANEL DISCUSSION NO. 5 (ASME)—CRYOGENIC HEAT TRANSFER. Moderator: R. B. Scott, U. S. Bureau of Standards. Panelists: T. Buckhold, General Electric; R. Glover, Univ. of North Carolina; W. Kahl, Linde; C. McKinley, Air Products.

2:00-5:00 P.M.

SESSION NO. 11. Chairman: A. C. Mueller, Dupont (A.I.Ch.E.). Co-chairman: J. A. Clark, Univ. of Mich. (ASME).

High Intensity Natural Convection Heat Transfer Near the Critical Point, C. P. Bonilla & L. A. Sigel, Columbia Univ.

Natural Circulation Tests with Water at 800 to 2,000 psia under Non-Boiling, Local Boiling, and Bulk Boiling Conditions, O. J. Mendler, A. S. Rathbun, N. E. Van Huff, & A. Weiss, Westinghouse Electric.

An Experimental Investigation of Partial Film Boiling with Water at Elevated Pressures in a Round Tube, E. C. King, J. B. Donough, & W. Milich, Mine Safety Appliances Research.

The Effect of Trace Additives on the Heat Transfer to Boiling Isopropanol, T. Dunskus & J. W. Westwater, Univ. of Ill.

Nucleate-Boiling Studies with Aqueous ThO_2 Slurries, D. G. Thomas, ORNL.

Determination of Boiling Film Coefficient for a Heated Horizontal Tube in Water-Saturated Wick Materials, W. D. Allingham & J. A. McEntire, Boeing Airplane.

SESSION NO. 12. Chairman: K. A. Gardner, Yuba Consolidated Indst. (ASME). Co-chairman: E. C. Ashton, Jr., Downingtown Iron Works (A.I.Ch.E.).

Shell and Tube Heat Exchangers: Effect of Bypass and Clearance Streams on the Main Stream Temperature, B. E. Short, Univ. of Texas.

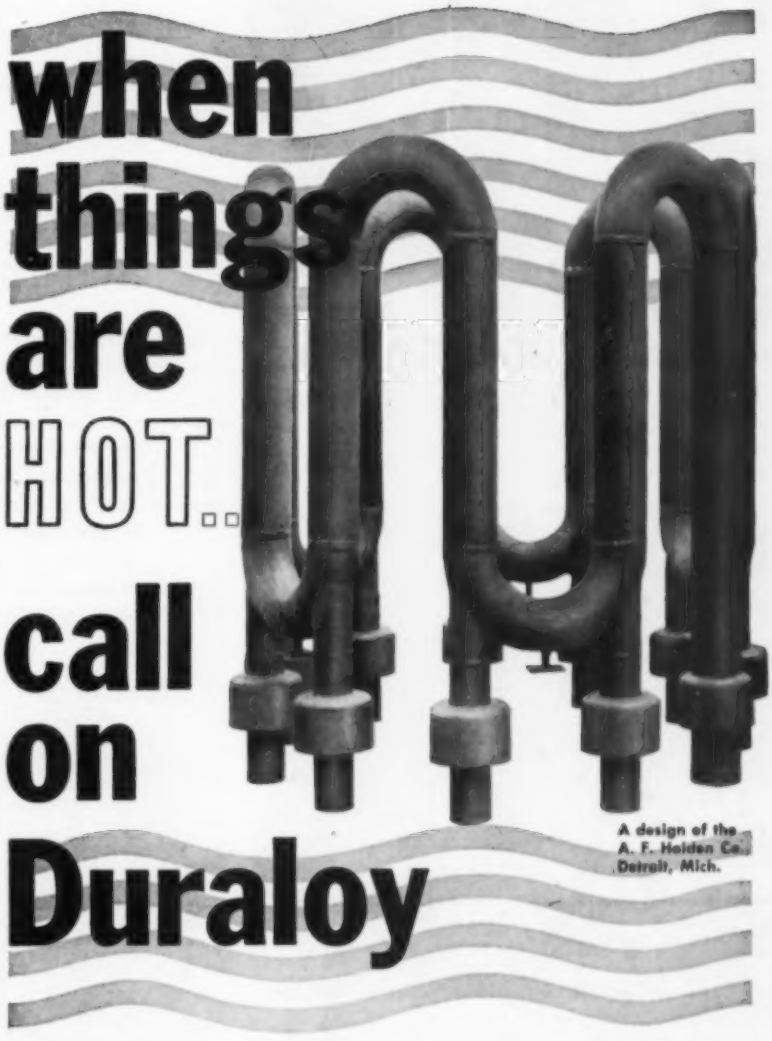
Possibilities of Using Plastic Film as an Economical Substitute for Metal in Heat Exchangers, J. M. Weaver, Chicago.

Optimization of a Sandwiched Thermoelectric Device, B. W. Swanson, E. V. Somers, & R. R. Heikes, Westinghouse Electric.

Scraped-Surface Heat Exchangers. Part 1—Power Consumption. Part 2—Heat Transfer, A. H. P. Skelland, L. S. Leung, D. R. Oliver, & S. Tooke, Ill. Inst. of Tech.

An Experimental Investigation of the Suitability of JP-4 Fuel for Regenerative Cooling of a Hypersonic Ramjet Engine, R. A. Dutton, Marquardt.

Selection and Use of High Temperature, Leakproof Canned Pumps, H. A. Thornton & A. D. Fel' Jr. Fostoria Corp.



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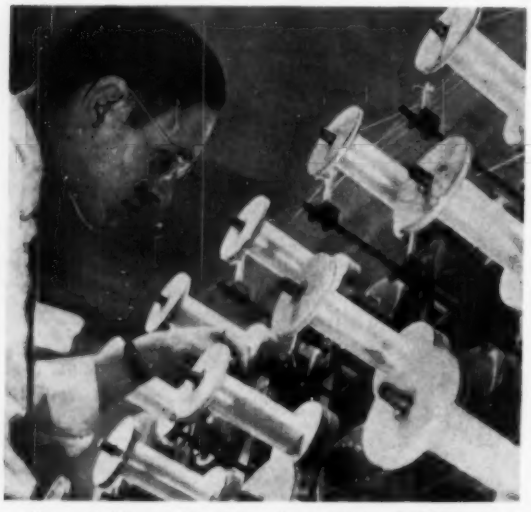
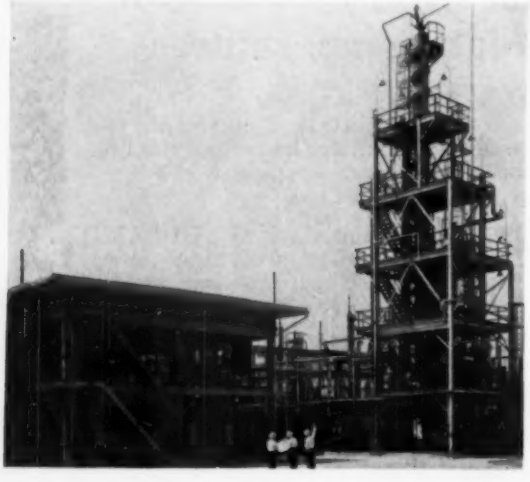
Polypropylene at Humble

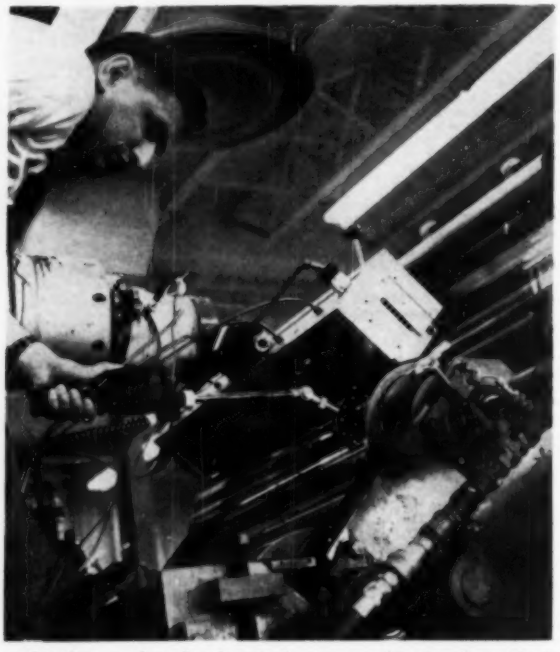
When Humble Oil & Refining Co., domestic branch of Standard Oil Co. (N.J.) put its 40 million pound per year polypropylene plant onstream at Baytown, Texas, it marked the turning of a new corner for Jersey. For despite the selling of $250 million of chemicals last year, the company was not directly in the plastics business until it started up the new plant. Building of the unit was the culmination of a $30 million program including research and development work.

1 Jersey started its formal work by getting a license to use the Ziegler catalyst system, and then giving the ball to Esso Research and Engineering Co. personnel. Here ultra-violet rays are used to simulate sunshine in the testing of polypropylene strips.



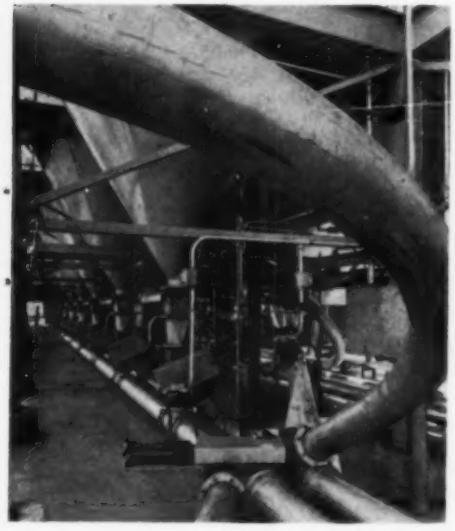
2 One of the outgrowths of research studies was a greatly improved catalyst with a tenfold increase in activity. Since catalyst is discarded once contaminated this was of great economic import. Plastic filaments were spun on commercial-sized equipment at Linden, N.J., labs as part of testing program.





3 Another major development was an improved method for removing catalyst residues from finished polymer, all-important in getting high-purity product. Film is a prime end-use for polypropylene and sheet extruders received a workout during laboratory development operations again on commercial equipment.

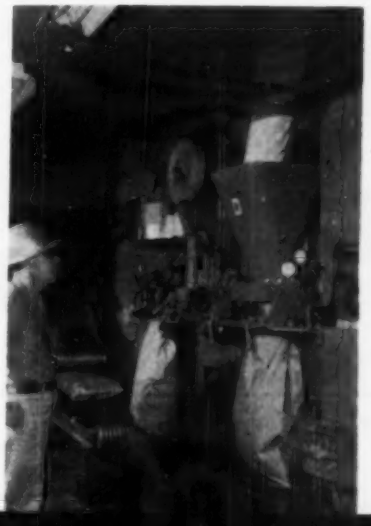
4 A big step forward was the development of a continuous process by Esso. Process details were worked out in a one ton per day pilot plant constructed at the Baton Rouge, La., laboratories. Much of the product made on this unit ended up in the Linden laboratories where development continued.

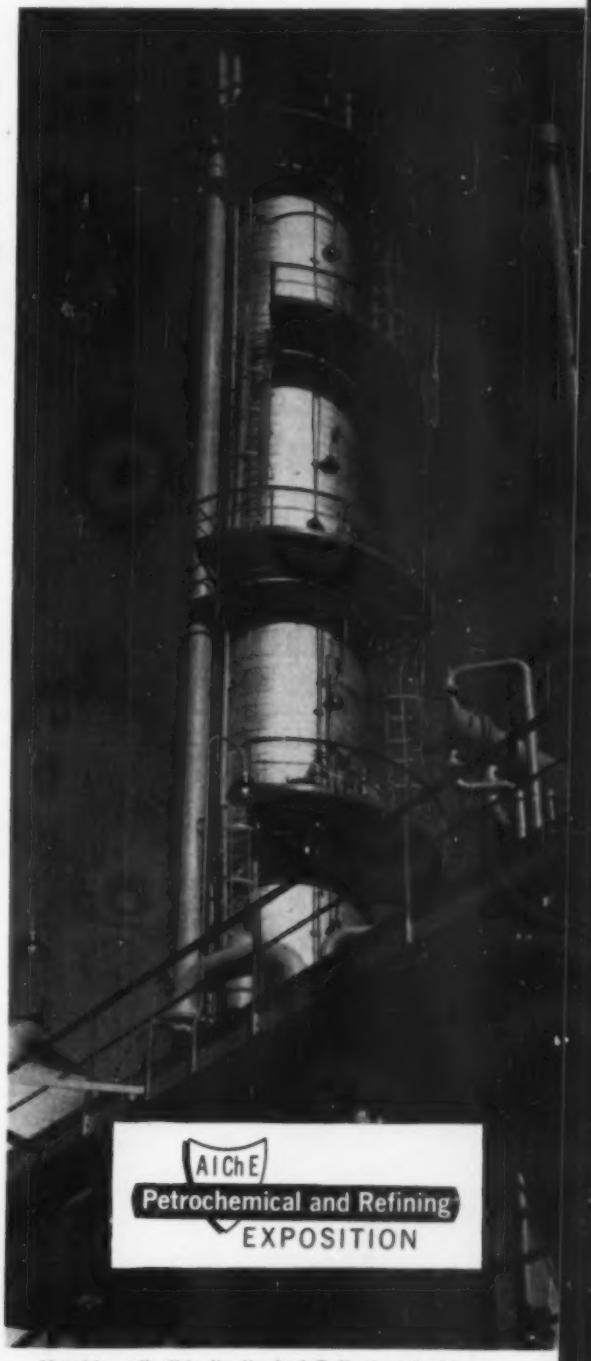


5 Placing plant on-stream ended a three-year master plan. Pneumatic conveyor system moves plastic pellets to packaging room at Baytown. Process includes propylene purification and catalyst preparation, polymerization, catalyst removal and polymer separation, solvent recovery, drying, extrusion, bagging and shipping.

6 Extruder at plant produces string-like polymer which is cooled and chopped into pellets for packaging and shipment to product manufacturers. Humble crews were responsible for complete job of building new plant adjacent to main refinery from where propylene is obtained from off-gases of catalytic cracking units.

7 End of the line is packaging section where pellets are bagged or loaded in cartons for shipment. Enjay Chemical Co., division of Humble, is marketer of the trademarked Escon polymer and a marketing agreement also has been made with Spencer Chemical. Increased demand is no worry since plant can easily be expanded to 100 million pound per year capacity.





8 Humble calls this its "polyolefin" plant looking to continued growth in this area. The overall petrochemical story throughout the world will be told at New Orleans, Feb. 26-March 1, 1961, when A.I.Ch.E. holds its Petrochemical and Petroleum Refining Exposition in conjunction with its National Meeting.

Separation processes, student awards at Philadelphia-Wilmington One-Day

WITH SEPARATION PROCESSES the general theme, seven papers dealing with liquid extraction, ion exchange, continuous crystallization, electro-membrane processes and tray design of fractionators were heard at the Philadelphia-Wilmington One-Day Meeting. The Annual Symposium was on March 29 at the University of Pennsylvania.

A relatively new concept, the penetration theory for explaining mass transfer operations, was compared with the film theory by L. Lapidus, Princeton U. In *Fundamentals of Mass Transfer Processes*, he stated that the film theory indicates a linear variation of the mass transfer coefficient, k_1, with diffusivity, D, whereas the penetration theory indicates a square root dependence. Results obtained from either model are essentially the same. However, it has been shown that the concentration profiles for mass transfer from a solid to a turbulent fluid can be fitted better by the penetration model than by the film theory. As a result of the penetration approach, it is now possible to estimate the effective contact area of a spray column from data on an essentially unrelated process.

Seated, (l. to r.) Fenske, Lapidus, Saeman. Rear, Scheibel, Moison.

Ion exchange

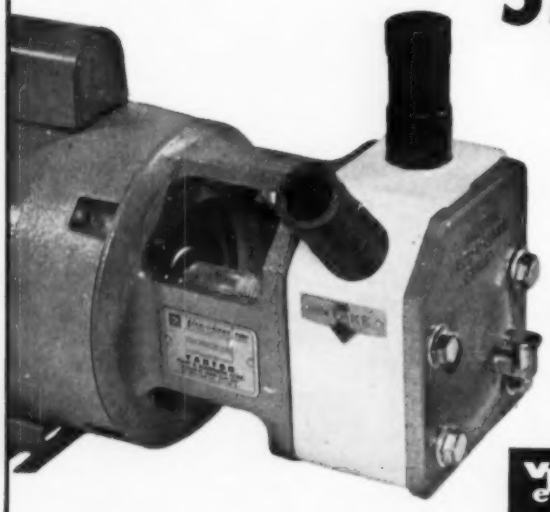
The results of recent fundamental investigations permit the design of ion exchange equipment using simple correlations similar to those employed in absorption, extraction, and distillation. R. L. Moison, Du Pont, listed current applications in *Ion Exchange:* removal of ionized impurities from drinking and boiler feed water, treatment of plant effluents for purification and recovery of valuable material, and purification of inorganic and organic chemicals.

In presenting *Design of Liquid Extraction Processes,* M. R. Fenske, Penn State, said that the basic principles of this process are often not properly understood. Yet they are fundamentally similar to distillation.

Developments in the relatively new field, *Electric Membrane Processes for Chemical Processing Applications,* were detailed by W. E. Katz, Ionics. Successful applications on a commercial basis are in electric membrane demineralization of saline water, and in recovering iron and sulfuric acid from waste pickle liquor solutions in the steel industry.

Water for aromatic extraction

The use of water could revolutionize the aromatics extraction process, says E. G. Scheibel, York Process. He considers water a more simple, eco-



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nomical solvent than any now in use, including the principle ones, diethylene glycol and sulfur dioxide. In *Separation of Aromatics and Paraffins by Solvent Extraction,* solubility data presented show that at 1500 lb./sq. in. gauge and 550° F water shows good selectivity for aromatics over paraffins. From this data, Scheibel designed an extraction unit. He also made an economic comparison between this process and the Udex Process.

Comparison of Tray Types in Fractionation Columns, R. S. Eagle, M. W. Kellogg, discusses the various downcomerless trays and downcomer type trays, both valve and fixed opening.

Scale-up and Performance Relations for Continuous Crystallizers, W. Seaman, Olin Mathieson. Shows effects of nucleation and crystal structure on performance.

Awards

Presentations were made to the winners of the Zeisberg Award Contest at the luncheon, held during the All-Day Symposium, where the winning students were guests of the section. First place went to Fred Kleiner, U. of Pennsylvania. Second place, to Mathew G. Zellner, Lehigh U. and Third place to Ernest Eissele, U. of Delaware. Entries consisted of theses, term papers, or lab projects. Aim of the annual contest is to encourage chemical engineering students to develop proficiency in writing technical reports. The prize consists of technical or scientific books, to be chosen by the winner.

Chemical warfare

Chemical weapons are the most effective, most readily available, humane and productive methods of warfare we have today, according to Major General William Creasy. The former chief of Chemical Warfare Service, U.S. Army, in declaring his support for debilitating agents in warfare, rather than lethal, said that he is particularly concerned from the point of view of effectiveness. Now vice president and manager, New York Division, Lummus Company, Creasy addressed the April meeting of the New York Section.

Creasy categorically stated that he opposed our international policy of retaliation only in connection with CBW. But, he added, people are not ready to accept the fact that offense is the best defense.

The advantages of chemical warfare are: selective effects: CBR weapons can incapacitate only, or kill a predetermined percentage.

Reverse behavior pattern for a pe-

continued on page 132

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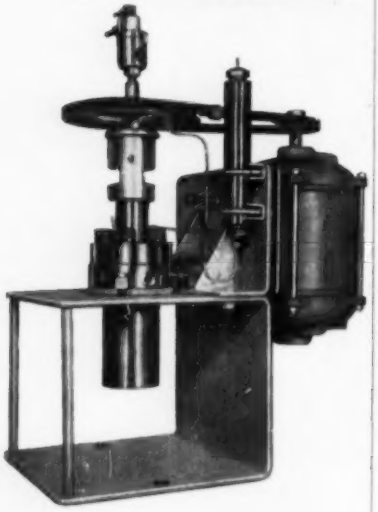

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Local sections

from page 131

riod of 24-72 hours, with startling results.

Difficult to detect, particularly since it is possible that unknown agents might be used.

Inexpensive (this puts it within the range of smaller countries).

Figures on the relative effects of CBR weapons, issued at a symposium at the recent national ACS meeting in Chicago show:

At the moment, there is no legal prohibition against the use of chemical warfare. The Soviet Union has signed such an agreement, but they have stated that this was not valid against countries that have not signed. In Creasy's opinion, the Russian stockpile at the moment is greater than ours. They have attempted with some success to get us into the position where it is felt that if we talk about CBR the psychological effect would be to heighten world tension, and world opinion is unfavorable.

	Nuclear agents	Chemical	Biological
Immediate effective area	75-100 sq. miles	100	34,000
Human lethality	98%	30% (not necessarily lethal)	25-75%
Detection	simple	complex, but rapid	slow
Time	seconds	7½ seconds to 30 minutes	up to 14 days

St. Louis One-Day

A record number (283) attended the highly successful Second Annual All-Day Symposium of the **St. Louis Section** in March.

On the technical program, of particular interest was the discussion on pollution. Several papers were presented: *Factors Affecting Stream and Air Pollution*, H. H. Hilliker, Missouri State Pollution Board; *A Simplified Continuous Liquid Stream Sampler*, J. W. Miller, Mallinckrodt Chemical; *Alumina Based Catalysts for Motor Exhaust Clean-up*, E. E. Marshall, Alcoa Research Lab; *Monsanto's Pollution Abatement Program*, C. N. Stutz; *Immobilization of Radioactive Wastes*, R. H. Luebbers, University of Missouri.

Also on the agenda were *Grinding*

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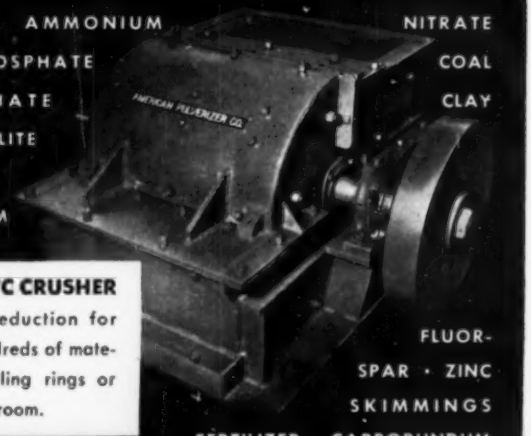

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Jerry McAfee addressing luncheon group at St. Louis All-Day Meeting.

and Size Classification, and *Modeling and Photographic Techniques*. A 5-paper general session wound up the meeting's technical side.

Jerry McAfee was featured speaker at the luncheon. He addressed the group on *The A.I.Ch.E., What and Why*.

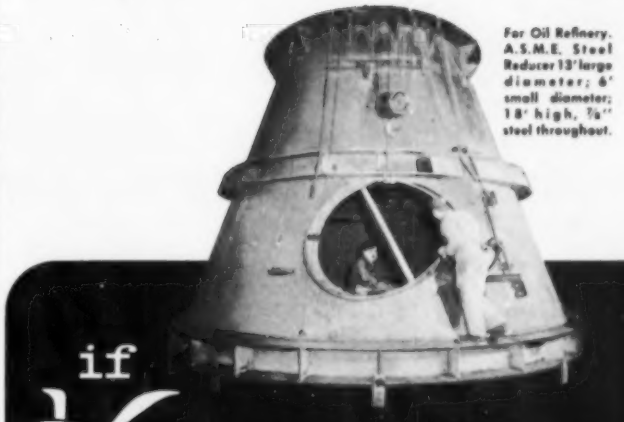
Automation and employment

Automation will be a necessity to produce the chemicals demanded by an increased population because the prime labor force of men in the 25-34 age group will probably decline within the next five years. Speaker was K. R. Knoblauch, manager, chemical markets, Minneapolis Honeywell Regulator. Occasion: **Southern California Section** *(J. F. Keville)* February meeting. Employment, he continued, will thus be limited in its expansion more by a shortage in the prime labor group than by the expected increase in plant automation.

For best results, the process should be matched with the automation. When applied to old plants, automation may be unrewarding. Complete automation will be most profitable where raw materials can be moved in bulk, where operations are repetitive and standardized, and where volume is high.

The biggest problem with increased automation is that at present, a Ph.D. is apt to be required to repair the instruments. However, by the time complete automation becomes common, built-in instrument loop checking devices will be developed which will enable instrument mechanics to locate troubles in the control loop without leaving the central control station.

Knoblauch estimated that 50 percent of instrument sales now are to the six largest chemical companies. Along with increased automation, electric instruments are expected to increase their share of the market to about 50 percent of new purchases in 1965. The volume of pneumatic instruments will remain at present levels, and electric instruments will add to the volume, he concluded.



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Hachmuth cited for industry service

Karl H. Hachmuth has received the Hanlon Award of the Natural Gasoline Association of America (NGAA), highest honor in the natural gasoline industry and one of the ranking awards in the petroleum industry. Hachmuth, staff consultant, research and development at Phillips Petroleum, is the 24th recipient of the annual award, which is conferred for outstanding service to the natural gasoline industry.

The citation read in part: We are honoring this man because his ever curious mind, his imaginative approach to the problems of hydrocarbon chemistry, and fundamental chemical engineering studies combined to benefit the industry. More specifically, we are recognizing his long and continued work in the development of equilibrium ratio and enthalpy data, and his practical application of that data in extraction and separation processes. His experimental determinations led to basic concepts which have resulted in great advances in petrochemistry, and to new and useful products from natural gas liquids.

Hachmuth's degree in chemical engineering was received from the University of Michigan in 1925. In 1927, he joined Phillips Petroleum as pilot plant engineer, and has been with them ever since. For several years he headed all fundamental chemical engineering studies, including design and operation of pilot plants. These responsibilities later took in commercial process design. Much of his time in recent years has been spent in the fundamental studies of Fractionation Research, Inc., a cooperative project involving many of the leading oil companies. Hachmuth is a director of A.I.Ch.E.

Presentation of the 1960 Award was made at the 39th Annual Convention of the NGAA in Houston, Texas.

Officers of the A.I.Ch.E.'s Nuclear Engineering Division for 1960 are: **W. A. Rodger,** chairman; **C. E. Stevenson,** vice chairman; **C. E. Dryden,** secretary-treasurer. Executive committee members are: **C. F. Bonilla, J. W. Clegg, O. E. Dwyer** and **R. B. Richards.**

Donald D. Davidson has been elected a vice president of Golden Bear Oil Co. He will be responsible for all manufacturing operations for the Los Angeles firm.

Ira W. Hutchison has been named

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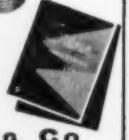

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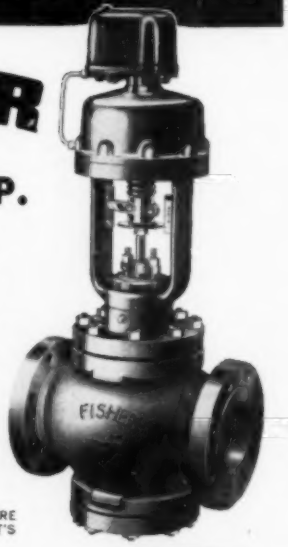

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president of Dow Corning International, S.A. Hutchison joined Dow Chemical in 1940, and Dow Corning in 1943. He continues as manager, International Department, Dow Corning, a post he has held since its formation in 1953.

In key staff changes at Ludlow Papers, **Austin W. Fisher, Jr.** (left) moves up to the post of vice president, to take charge of the company's over-all technical program. **Howard H. Reynolds** succeeds him as research director. Reynolds comes to Ludlow from W. R. Grace, where he was manager, Technical Department, Cryovac Division. Another addition to the Massachusetts firm is **Robert M. Yahres,** as director of Quality Control.

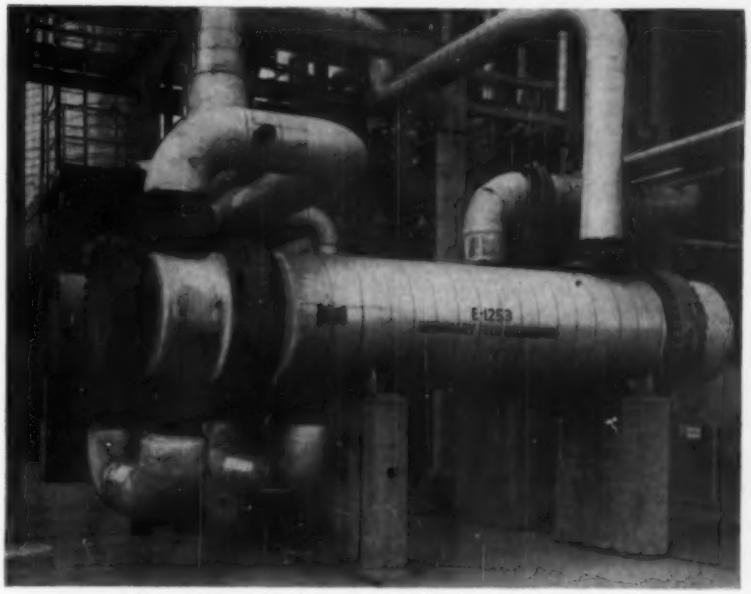
William B. Hudson, Jr. has been elected vice president, in charge of refinery engineering, Arthur G. McKee and Co. A 1941 graduate of Drexel Institute of Technology, Hudson was for 19 years associated with Foster Wheeler, most recently as manager, Petroleum Refinery Department and of foreign operations.

Chalmer G. Kirkbride has been elected vice president of Sun Oil, in charge of research and engineering. Kirkbride came to Sun as executive director, research and engineering in 1956, after serving as president and chairman of the board, Houdry Process. He is president, AviSun, and a director of SunOlin Chemical and of the Houdry Corp. A past president of A.I.Ch.E., he is the author of a text book on chemical engineering. Kirkbride also holds several patents on petroleum refining processes.

In top management changes at Singmaster & Breyer, **Byron Marquis** (left) was appointed president of the company, and **Frank G. Breyer** became chairman of the advisory committee. Breyer, one of the founders of the firm, was previously chairman of the board. He holds more than 50 pa-

continued on page 136

For more information, turn to Data Service card, circle No. 44



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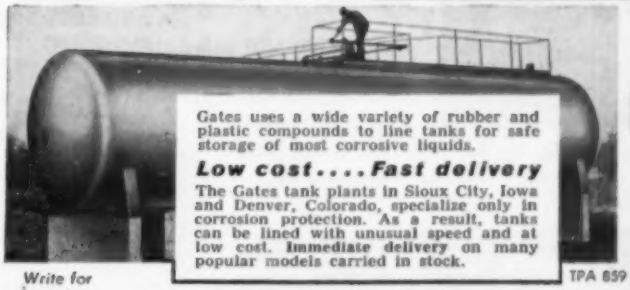

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TPA 859

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Gates

For more information, turn to Data Service card, circle No. 86

People

from page 135

tents, most of them covering the extraction of metal from ore, and the use of pigments as compounding agents in paint, rubber and plastics. Marquis has been a partner in the firm since 1945. He holds patents on pigment processes and chemical engineering equipment.

Harry B. Warner (right) has taken over as president, B. F. Goodrich Chemical. Formerly vice president, marketing, Warner has also served as vice president, development, and in various manufacturing, engineering and field assignments, both in the United States and overseas. He succeeds **John R. Hoover,** who retired after 35 years with the company. In other appointments, **Thomas B. Nantz** steps into Warner's post of vice president, marketing, and **Robert D. Scott** takes over as vice president, manufacturing and development.

Maurice E. Brooks, Lummus Company director of engineering, has been elected a vice president of the company. Brooks joined Lummus in 1940 as a process engineer. He has since served as senior process engineer and manager of the company's French subsidiary, as assistant to the vice president of engineering, and in other executive posts. A graduate of Cooper Union School of Engineering, Brooks also attended Brooklyn Polytechnic Institute and New York University graduate schools.

Lloyd Brownell, professor of chemical and metallurgical engineering at the University of Michigan, has been granted leave for the second semester of 1960. He will serve as a consultant to ICA in Indonesia, where he will assist in the design of a radioisotope center for that country.

New appointments in the Cities Service Research and Development process research lab at Lake Charles, La. are **John J. Hagan,** senior research engineer; **J. T. Kelly,** head of the division, and **H. M. Knight,** senior research chemist.

Hal M. Hart has been appointed a project director, Whiting laboratories, Standard Oil (Indiana). He will be responsible for developing new ways to use electronic computers in controlling selected processes for refining petroleum.

Dwight L. Miller has been named assistant director, U. S. Department of Agriculture, Northern Research Laboratory. His previous position with the Agricultural Research Service was assistant to the director.

At Newport Industries, **Arnold A. Arndt** has been appointed plant manager of Pensacola, Fla. operations. Arndt's background includes operations, administration, and engineering in heavy chemicals, pharmaceuticals, and high energy fuels.

C. C. Oldenburg has assumed the post of senior research engineer, Richmond laboratory, California Research. Also at the Richmond lab, **R. J. Mitchell** has been appointed group supervisor, refinery technical service.

Jean R. Okel has joined Cyprus Mines Corp. as manager, chemical projects. Okel was formerly senior chemical engineer with C. F. Braun.

continued on next page

BIG NAMES

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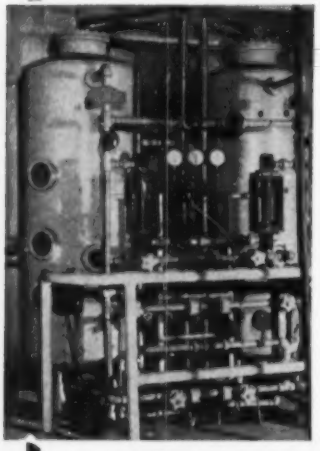

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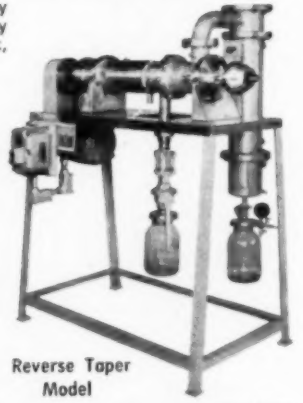

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Facts-of-Life for successful engineers must include attitude, self-appraisal, vision, understanding, respect, relaxation and "happiness"

Achieving "success" and/or "happiness" in your professional and personal future won't just "happen," regardless of how diligently you apply yourself to your daily tasks, unless your efforts are coordinated along specific paths of endeavor. Your life as an engineer must be counterbalanced by your life as an individual — because "engineers ARE human," despite comment to the contrary.

The engineer reacts to the same human stimuli and motivations as the man in the accounting division, the sales department, the repair and maintenance crew, the general office force, or in the management division. All are motivated to varying extents by the same drives for recognition, self-respect, material progress, functional importance, personal pleasure, financial stability — and "security," however, the latter is translated.

The fact of the matter is no longer "theoretical," it is accepted, proven, practical "common-sense": to accomplish either or both of these achievements, your pursuit of "happiness" and/or "success" must have (a) ambition, (b) definition, (c) purpose, (d) direction. It is a life-long pursuit, subject to many detours and changes. In the pursuit itself, however, will be found much of its own reward.

One of our basic problems seems to stem from our relationships with *others* — our reactions to the drives of other people and their reactions to ours, because, like it or not, we *are* affected by other people, and they are affected by us.

Professionally, we are affected by our superiors, associates and subordinates — both technical and non-technical. Personally, we are affected by our family, our relatives and our friends — on and off the job. Our object then, is to ascribe to both our professional and personal life those qualities and human attributes which bring professional success and personal happiness. *We must develop a formula for living.*

This limited space, of course, does not permit a full look at this most complex of subjects, but a more complete treatment of human relations in engineering is found in a booklet entitled "Success and/or Happiness — in Engineering," available free upon request. Write for your copy to WESTERN SUPPLY COMPANY, HEAT EXCHANGER DIVISION, P. O. BOX 1888, TULSA, OKLA. — and remember, *our* success and happiness stems partially from the heat exchangers in *your* future.

For more information, circle No. 26

People

continued

Hayden B. Kline, president of Industrial Rayon, became chairman of the board of directors of the merged Industrial Rayon and Texas Butadiene & Chemical Companies.

Raife G. Tarkington has been named associate head, Applied Photography Division, Kodak research laboratories. Serving five years in the Army during World War II, Tarkington was an Air Force Lieutenant Colonel and assistant chief, Wright Field photographic laboratory by 1946. Except for these years, he has been with Eastman Kodak since 1936.

Donnell H. Wagner has joined Baxter Laboratories as chief engineer. He comes to the Morton Grove, Illinois, firm from Campana Corp., where he was an assistant vice president.

William J. Shelley moves into the newly created position of director of administration, Uranium Division, Mallinckrodt Chemical Works. **J. Harold Yeager** has been named technical director at Weldon Spring, Missouri.

Jay Robert Martin has joined the staff of the Tonawanda Laboratories, Linde Company (Union Carbide). He is in the chemical engineering section, Engineering Lab.

Robert R. Pierce has been elected chairman of the Inter-Society Corrosion Committee. Pierce, who is manager, Corrosion Engineering Products Department, Pennsalt Chemicals, will serve for a two year term. Formerly vice chairman of the Committee, he was A.I.Ch.E. representative for several years. Sponsored by NACE, the Committee is made up of two delegates from each of 35 U. S. technical societies, and 13 foreign delegates.

Rowland F. Hein has been promoted to research supervisor in chemical engineering at Du Pont's Jackson laboratory. A graduate of the University of Minnesota, he received his Ph.D. there in 1952, after which he joined the Jackson lab staff as a research engineer.

Samuel Kruty, in his new post of pro-

continued on page 139

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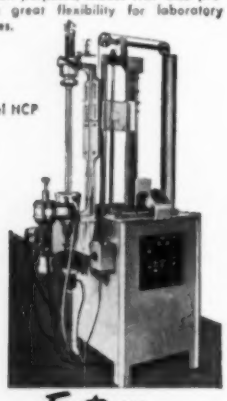
FLOATING ZONE UNIT FOR METAL REFINING AND CRYSTAL GROWING

A new floating zone fixture for the production of ultra-high purity metals and semi-conductor materials. Purification or crystal growing is achieved by traversing a narrow molten zone along the length of the process bar while it is being supported vertically in vacumm or inert gas. Designed primarily for production purposes, Model HCP also provides great flexibility for laboratory studies.

Model HCP



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- A smooth, positive mechanical drive system with continuously variable up, down and rotational speeds, all independently controlled.
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AUDITOR'S REPORT

We have examined the balance sheet of the American Institute of Chemical Engineers as of December 31, 1959 and the related statement of income and surplus for the year then ended. Our examination was made in accordance with generally accepted auditing standards and accordingly included such tests of the accounting records and such other auditing procedures as we considered necessary in the circumstances.

In our opinion, the accompanying balance sheet and statement of income and surplus present fairly the financial position of the American Institute of Chemical Engineers at December 31, 1959, and the results of its operations for the year then ended, in conformity with generally accepted accounting principles applied on a basis consistent with that of the preceding year.

F. W. LAFRENTZ & Co.
Certified Public Accountants

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS

BALANCE SHEET
DECEMBER 31, 1959
ASSETS

Current assets:		
Cash on hand and demand deposits	$106,368.42	
Cash in savings institutions	30,995.96	
Total	$137,364.38	
Less cash in Trust and Special Funds	255.15	$137,109.23
Investments at cost and accrued interest	$270,451.69	
Less investments in Trust and Special Funds	5,386.25	265,065.44
Accounts receivable, net		27,526.69
Inventory, at cost		13,491.95
Employees expense advances		2,645.95
Prepaid expenses		3,022.58
Total current assets		$448,861.84
Deposits		1,876.02
Total		$450,737.86
Trust and Special Funds:		
Albert E. Marshall Fund	$ 3,016.44	
Frederic C. Bowman Fund	1,238.71	
Ernst Berl Fund	1,386.25	5,641.40
Total		$456,379.26

LIABILITIES

Current Liabilities:	
Accounts payable	$ 31,710.88
Deferred income	207,861.82
National Science Foundation Grants	25,761.54
Education and preprint funds	3,080.39
Surplus	182,323.23
Total	$450,737.86
Trust and Special Funds (as set forth above)	5,641.40
Total	$456,379.26

STATEMENT OF INCOME AND SURPLUS
FOR THE YEAR ENDED DECEMBER 31, 1959

Income:		
Membership dues	$313,953.08	
Less allocation to subscriptions	77,280.37	$236,672.71
Membership entrance fees		6,925.00
Publications		571,986.23
Investments		10,642.59
Other		4,755.00
Total income		$830,981.53
Expenses:		
Publications		$300,309.44
Salaries and commission		390,082.54
Retirement plan and federal insurance contributions		10,924.47
Rent and electric		27,165.78
Postage, telephone and telegraph		32,275.02
Printing, stationery and supplies		21,093.45
Meetings		12,213.36
Office equipment and machine rental		11,612.14
Committees		14,494.46
Participation in professional groups		8,832.00
Engineering Societies Personnel Service, Inc.		3,000.00
United Engineering Center Campaign		1,796.73
Awards		1,837.10
Other		11,864.37
Total expenses		$847,500.86
Net loss for year		$ 16,519.33
Surplus, December 31, 1958		198,842.56
Surplus, December 31, 1959		$182,323.23

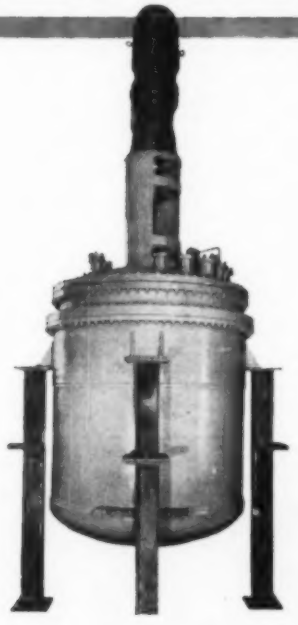
REACTION VESSELS

designed and built

BY BETHLEHEM

assure

- **lower first cost!**
- **less maintenance!**
- **fewer shutdowns!**



For the Reaction Vessel above, complete with agitator and drive, a special cast iron composition was selected to increase life. Extremely low maintenance costs were made possible by use of a Stellited shaft in the stuffing box to avoid scoring and wearing of shaft by packing. Heavy duty gear reducer with minimum bearing runout, drives the agitator shaft. Replacement or adjustment of bearings can readily be made without lengthy shutdowns or expensive repairs.

Bethlehem manufactures Vessels in cast iron and fabricated steel, stainless steel, alloys, and clad to ASME codes and to the highest specifications and standards. X-ray is just one of the techniques used to insure sound construction for demanding service. WE INVITE YOUR INQUIRIES.

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For more information, circle No. 32

People

from page 137

duction manager, Dearborn Chemical, will head up manufacturing operations for all Dearborn product lines. He will have offices both at Lake Zurich, Illinois, and at Chicago.

William B. Yarborough has taken over the new position of vice president, responsible for research, development, and engineering, at Allied Chemical's National Aniline Division.

Other appointments at National Aniline are **John M. Esposito** and **Stephen Duch,** Engineering Department, Buffalo, New York, plant. In the Plastics and Coal Chemicals Division, **Kenneth D. Meiser** is assistant director of engineering, Technical Department.

Marketing

Gerald F. Koepplinger steps into the post of general sales manager, Mooney Brothers Corp. He has been with the Little Falls, N. J. firm for ten years, and was sales engineer until recently.

Necrology

Gerald L. Eaton, 53, director of research and development, United Engineers & Constructors. He had been with the Philadelphia firm since 1944. Previously Eaton had worked in the development of new processes for oil cracking and gas polymerization, both at Atlantic Refining and at Gulf Oil. The author of many technical papers relating to thermal cracking of petroleum fractions, Eaton held seven patents. A scholarship established at Acadia University, Nova Scotia, where he did his undergraduate work, will be known as the Gerald L. Eaton Scholarship in Chemical Engineering.

Harry J. Karakas, 52, manager of the New York sales office of Rodney Hunt Machine Co. Before joining the Orange, N. J. firm in 1956, Karakas had been associated with Pfaudler, the Patterson Foundry & Machine Co. and the Interchemical Co.

Henry T. Ward, 63, head of the Department of Chemical Engineering at Kansas State University, since 1948. Ward also headed the Chemical Engineering Department at the University of Arkansas during 1947-48. Previously, he taught at the University of Wyoming, Montana State College and Drexel Institute of Technology. During his tenure at Kansas State, the department became accredited by the ECPD, a Ph.D and a nuclear engineering curriculum were instituted.

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The Fike CPV unit is more rugged than conventional rupture discs of equal rupture pressure. It is more easily handled and there is less danger of damaging the rupture disc during installation from over torque or slight inclusion of foreign matter on seating surfaces of flanges.

Sizes range from 1" to 24" with rupture pressure ranging from 4 to 850 lbs. PSIG at 72° F. Metals available depending on size, include aluminum, copper, silver, nickel, monel, inconel and stainless steel. Any of the above materials furnished with plastic dispersion coats or sheet plastic lamination for various corrosive conditions.

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future meetings

1960—MEETINGS—A.I.Ch.E.

• Buffalo, N. Y., Aug. 14-17, 1960. Statler Hilton Hotel. **4th National Heat Transfer Conference & Exhibit. Sponsored by A.I.Ch.E. & ASME. A.I.Ch.E.** sponsored panel discussion on **Discrepancies Between Design Procedure & Plant Operation.** Moderated by D. Q. Kern. Panelists: D. J. Bergman, Union Oil; C. H. Brooks, Sun Oil; C. H. Gilmour, Union Carbide Chem.; A. C. Mueller, Dupont. A.I.Ch.E. papers to S. W. Churchill, U. of Mich., Ann Arbor, Mich. ASME papers to J. P. Hartnett, U. of Minnesota, Minneapolis, Minn. Exhibit info to P. A. Jolcuvar, A.I.Ch.E., 25 West 45 St., N. Y. 36, N. Y.

• Cambridge, Mass., Sept. 7-9, 1960. M.I.T. **Joint Automatic Control Conference.** Sponsored by A.I.Ch.E. AIEE, IRE, ASME, ISA. For A.I.Ch.E. info refer to: W. H. Abraham, Eng. Exp. Sta., Dupont, Wilmington 98, Del.

• Tulsa, Okla., Sept. 25-28, 1960. Hotel Mayo. **A.I.Ch.E. National Meeting.** Gen. Chmn.: E. W. Kilgren, Pan Am. Petrol. Corp., Tulsa, Okla. Tech. Prog. Chmn.: K. H. Hachmuth, Phillips Petroleum Co., Bartlesville, Okla. **Multiphase Flow in the Production & Drilling of Oil Wells**—L. P. Whorton, Atlantic Refining, Box 2819, Dallas 1, Texas. **Natural Gas & Natural Gas Liquids**—R. L. Huntington, U. of Oklahoma, Norman, Okla. **Advances in Refinery Technology**—W. C. Offutt, Gulf R&D Co., P. O. Drawer 2038, Pittsburgh 30, Pa. **Petrochemicals**—C. V. Foster, Continental Oil Co., Ponca City, Okla. & H. L. Hays, Phillips Chem. Co., Bartlesville, Okla. **Piloting or Why Buy the Restaurant When All You Need is a Meal**—R. E. Weis, Phillips Pet. Co., Bartlesville, Okla. & D. Popovac, Continental Oil Co., Ponca City, Okla. **Corrosion & Materials of Construction**—W. A. Luce, The Duriron Co., P.O. Box 1019, Dayton 1, O., & M. S. Whorley, Black, Sivalls & Bryson, P.O. Box 1714, Oklahoma City, Okla. **Statistics and Numerical Methods Ap-**

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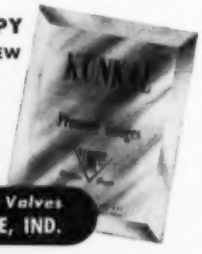

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plied to Engineering—R. L. Heiny, 2709 Jefferson, Midland, Mich. **Air & Ammonia Plant Safety**—G. Weigers, Amer. Cyanamid Co., P.O. Box 10008, Jefferson Branch, New Orleans 21, La. **Refinery & Natural Gasoline Plant Safety**—J. N. Romine, Phillips Petrol., Bartlesville, Okla. **Processing Agricultural Products**—A. Rose, Tex. Eng. Exp. Sta., Tex. A&M, Coll. Sta. Tex. **Chemical Reactions Induced or Modified by Radiation**—J. J. Martin, Ch.E. Dept., U. of Mich., Ann Arbor, Mich. **Conservation & Utilization of Water**—F. J. Lockhart, Ch. E. Dept. of U. of So. Cal., 3551 University Ave., Los Angeles 7, Cal. **Foams**—C. S. Grove, Jr., Syracuse U., Syracuse 10, N. Y. & R. L. Tuve, U.S. Naval Rsch. Lab., Wash. 25, D.C. **Computers as a Management Tool**—R. Cxiner, Grace Chem. Co., 3 Hanover Square, New York 4, N. Y. **Non-Newtonian Fluid Mechanics**—A. B. Metzner, U. of Delaware, Newark, Del. **Student Program**—O. K. Crosser, Univ. of Oklahoma, Norman, Okla. **Selected Papers**—R. H. Perry, Ch.E. Dept. U. of Oklahoma, Norman, Okla.

• Washington, D.C., Dec. 4-7, 1960. Statler Hotel. **A.I.Ch.E. Annual Meeting.** Gen. Chmn.: J. L. Gillman, Jr., 1700 K St., N.W., Wash. 6, D.C. Tech. Prog. Chmn.: D. O. Myatt, Science Communication, Inc., 1079 Wisconsin Ave., N.W., Wash. 7, D.C. **Air Pollution**—A. J. Teller, U. of Florida, Gainesville, Fla. **Unsteady—State Instrumentation**—T. J. Williams, Monsanto Chem. Co., St. Louis, Mo. **Fluid Dynamics**—A. C. Acrivos, U. of California, Berkeley, Calif. **Information & Communications**—R. O'Dette, NSF, Wash., D.C. **Nuclear Reactor Operations**—R. L. Cummings, Atomics International, Canoga Park, Calif. **Nuclear Chemical Plant Safety**—C. E. Dryden, Ohio State U., Columbus, O. **Phase Transitions**—G. Bankoff, Northwestern U., Evanston, Ill. **Sales Overseas**—J. Costigan, The Sharpless Corp., 501 Fifth Ave., New York 17, N.Y. **Chemical Engineering—A Vital Link in Broadening the Uses of Agriculture Crops**—J. E. Simpson, U.S.D.A. **Chemical Warfare-Dispersal of Materials in Aerosol Form**—L. E. Garono, Army Chem. Corps. **Role of the Chemical Engineer in Environmental Health Engineering**—W. L. Faith, Air Pollution Foundation, 2556 Mission St., San Marino, Calif. **Feeding, Clothing, and Protecting the Combat Soldier**—Leo Spano, Quartermaster R&Eng. Command, Natick, Mass. **Phenomena Affecting Materials in Extreme Environments**—J. Hearne, Air Force R&Eng. **Impact of Govt. Programs on Chemical Engineering Education**—W. K. Davis, Bechtel Corp. **Toxic Plant Construction**—L. E. Garono, Army Chem. Corps. **Potentialities of Fuel Cells as Power Sources**—P. Greer, Army OOR. **Saline Water Conversions**—J. J. Strobel, OSW, Dept. Int. **Chemical Engineering in the Mineral Industry**—H. Perry, Chf. Bit. Coal Res. Br., U.S. BuMines. **Rocket Propellants**—W. E. Sheehan, DDRE. **Economic Evaluation of New Processes**—J. H. Hirsch, Gulf R&D Co., P.O. Drawer 2038, Pittsburgh 30, Pa. **New Crystallization Techniques**—H. M. Schoen, American Cyanamid Co., 1937 W. Main St., Stamford, Conn. **Heat Transfer**, Papers requested—M. Altman, Gen. Elec. Co., 3198 Chestnut St., Philadelphia, Pa.
Deadline for papers: July 5, 1960.

1960—Non-A.I.Ch.E.

• Ann Arbor, Mich. July 11-20, 1960. Univ. of Michigan intensive summer course **Applied Mathematics for Chemical & Metallurgical Engineers.** For info: K. H. Coats, Ch.E. Dept., 2028 East Engineering Bldg.; enrollment: R. E. Carroll, Engineering Summer Conf., 126 West Engineering Bldg.

• Cambridge, Mass. July 18-29, 1960. M.I.T. special summer program **Dynamics & Control of Ch.E. Processes.** For info: P. L. Thibaut Brian, Ch.E. Dept., M.I.T., Cambridge 39, Mass.

1961—MEETINGS—A.I.Ch.E.

• New Orleans, La., Feb. 26-March 1, 1961. Hotel Roosevelt. **A.I.Ch.E. National Meeting.** Gen. Chmn.: O. P. Wiedeman, Cyamamid, New Orleans, La. & H. E. O'Connell, Ethyl Corp., Baton Rouge, La. Tech. Prog. Chmn.: A. L. Regnier, Petroleum Chem., P.O. Box 6, New Orleans 6, La. **Brainstorming Technical Problems**—G. C. Szego, Space Technology Labs., P.O. Box 95001, Los Angeles 45, Calif. **Kinetics of Catalytic Reactions**—M. Boudart, Princeton U., Princeton, N.J. **Petrochemicals—Future of the Industry on the Gulf Coast**—J. A. Sherred, Monsanto Chem. Co., St. Louis 66, Mo. **Filtration**—P. M. Tiller, U. of Houston, Houston, Texas. **Settling**—A. G. Keller, La. State U., Baton Rouge, La. **Future Processing Technology** in

continued on page 142

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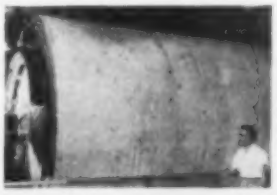

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Future meetings

from page 141

the Petroleum Industry—A. F. Kaulakis, Process Res. Div., ESSO. **Education and Professionalism**—R. P. Dinsmore, Goodyear Tire & Rubber Co., Akron 16, O. **Mathematics in Chemical Engineering**—R. L. McIntire, Mathematical Eng. Assoc., 3108 Sweetbriar, Fort Worth 9, Tex. **Evaluation of R&D Projects**—L. A. Nicolai, 239 Parsonage Hill Rd., Short Hills, N.J. **Liquid—Liquid Extraction**—R. B. Beckman, Carnegie Tech., Pittsburgh 13, Pa. **New Petrochemical Processes in the Area**—B. G. Caldwell, Dow Chem. Co., Plaquemine, La. **Materials of Construction**—R. V. Jelinek, Syracuse U., Syracuse, N.Y. **Thermodynamics**—J. J. Martin, Ch.E. Dept., Univ. Calif., L.A. 24, Calif. **Use of Probability Mathematics in Economic Evaluation**—A. G. Bates, Atlas Powder Co., New Murphy Rd., Wilmington 99, Del. **International Chemical Picture**—L. Resen, CEP. **Selected Papers**—E. Mannings, Shell Oil Co., Norco, La.
Deadline for papers: Sept. 5, 1960.

• Cleveland, O., May 7-10, 1961. Hotel Sheraton, Cleveland. **Joint A.I.Ch.E. National Meeting with Ch.E.Div. C.I.C.** Gen. Chmn.: H. Pforsheimer, Jr., Standard Oil Co. (Ohio), Cleveland, O. Tech. Prog. Chmn.: R. P. Dinsmore, Goodyear Tire & Rubber Co., Akron 16, O. **Petrochemicals as Starting Materials for Polymers**—L. P. Marek, A. D. Little, 30 Memorial Dr., Cambridge 42, Mass. **Fluid Mechanics**—W. H. Gauvin, McGill Univ., Montreal, Que. **Optimum Utilization of Pilot Plants**—J. T. Cumming, School Eng., Penn College, Cleveland 15, O. **Process Dynamics (Theoretical)**—R. M. Butler, Imperial Oil Co., Sarnia, Ont. **Synthesis Processes for Isoprene**—T. A. Burtis, Houdry Process Corp., 1528 Walnut St., Phila. 2, Pa. **Radioactive Materials for Process Control**—J. R. Bradford, College of Eng., Texas Tech. College, Lubbock, Tex. **Process Dynamics (Applied)**—L. M. Naphtali, Ch.E. Dept., Brooklyn Polytech., Brooklyn, N. Y. **New Synthetic Rubber Types**—P. M. Lindstedt, Goodyear Tire & Rubber Co., Ch.E.Div., Akron 16, O. **Coalescence**—R. Kintner, Illinois Inst. Tech., Chicago 16, Ill. **Management Criteria for Capital Investment**—C. F. Prutton, Food Machy. & Chem. Co., 161 E 42d St., New York 17, N. Y. **Ch.E. in Metal Refining**—W. M. Campbell, Chem. & Met. Div., Atomic Energy of Can., Chalk River, Ont. **Heavy Metal Mfr.**—L. P. Scoville, Diamond Alkali, Union Commerce Bldg., Cleveland 14, O. **Applications of High Speed Photography**—A. I. Johnson, Univ. Toronto, Toronto 5, Ont. **Bulk Fibrous Materials**—R. M. Christiansen, Stearns-Roger Mfg. Co., Denver, Colo. **Pulp and Paper**—J. L. McCarthy, Univ. Washington, Seattle 5, Wash. **New Research Techniques**—D. Hyman, Cyanamid, 1937 W. Main St., Stamford, Conn. **Mixing-Fundamentals**—J. Y. Olshue, Mixing Equipment Co., P. O. Box 1370, Rochester, N. Y. **Mixing-Applications**—E. E. Ludwig, Dow Chemical, Freeport, Tex. **Cash Flow Methods in Economic Analysis**—D. D. MacLaren, Esso Research & Engg., P. O. Box 215, Linden, N. J. **General Papers**—D. J. Porter, Diamond Alkali, P. O. Box 348, Rsch. Center, Painsville, O. **Student Program**—H. B. Kendall, Case Inst., 10900 Euclid Ave., Cleveland, O.
Deadline for papers: Dec. 7, 1960.

• Lake Placid, N. Y., Sept. 24-27, 1961. Lake Placid Club. **A.I.Ch.E. National Meeting.** Gen. Chmn.: B. I. MacDonald, Jr., G. E., Waterford, N. Y. Tech. Prog. Chmn.: E. R. Smoley, 30 School Lane, Scarsdale, N. Y. **Process Management; Commercial Chemical Development; Sales Engineering; Kinetics; Materials Handling; Growth Process Industries; Organization of Companies; Chemical Engineering in the Photographic Industry; Control of Corporate Investment Costs; Techniques and Practices in Plant Maintenance; Pilot Plants.**

• New York, N. Y., Dec. 3-6, 1961. Hotel Commodore. **A.I.Ch.E. Annual Meeting.** Gen. Chmn.: L. J. Coulthurst, Foster Wheeler Corp., New York, N. Y. Tech. Prog. Chmn.: A. V. Caselli, Shell Chem. Corp., 50 W. 50 St., N. Y. 20, N. Y. **Heat Transfer; Management; New Processes; Nuclear Engineering; Water Pollution; Process Dynamics; Pilot Plants; Fundamentals; Petroleum & Petrochemicals; Fluids; Fluidization; Sublimation; Adsorption; Student Program.**

Unscheduled Symposia

Correspondence on proposed papers is invited. Address communications to the Program Chairman listed with each symposium below.

Computers in Optimum Design of Process Equipment: Chen-Jung Huang, Dept. of Chem. Eng., Univ. of Houston, Cullen Blvd., Houston 4, Texas.

Solar Energy Research: J. A. Duffie, Director of Solar Energy Laboratory, Univ. of Wisconsin, Madison, Wis.

Hydrometallurgy—Chemistry of Solvent Extraction: G. H. Beyer, Dept. of Chem. Eng., Univ. of Mo., Columbia, Mo.

Process Dynamics as They Affect Automatic Control—D. M. Boyd, Universal Oil Prods., Des Plaines, Ill.

Drying—R. E. Peck, Ill. Inst. of Tech., 330 So. Federal, Chicago, Ill.

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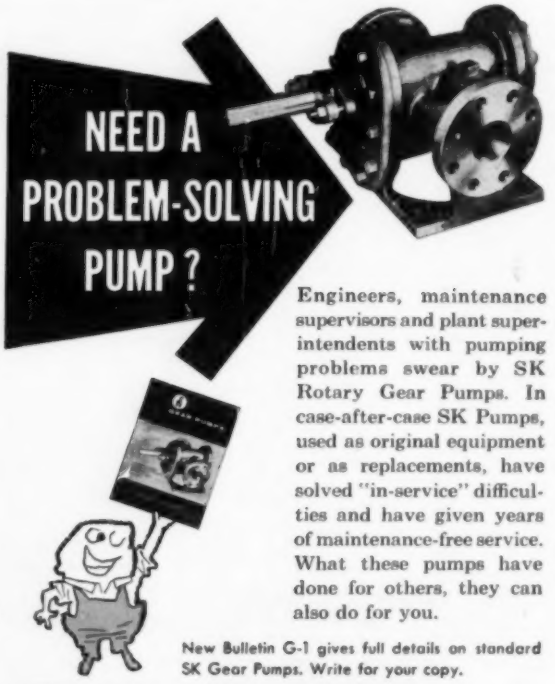

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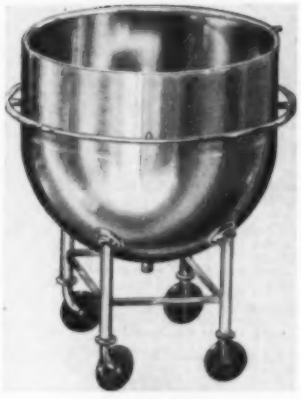

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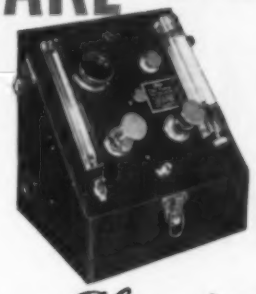

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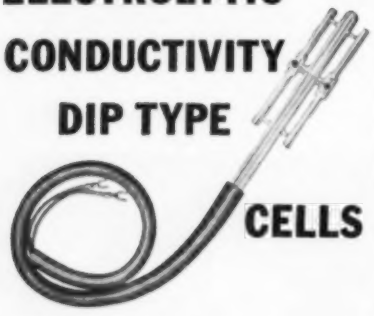

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The following is a list of candidates for the designated grades of membership in A.I.Ch.E. recommended for election by the Committee on Admissions. These names are listed in accordance with Article III, Section 8 of the Constitution of A.I.Ch.E.

Objections to the election of any of these candidates from Members and Associate Members will receive careful consideration if received before July 15, 1960, at the office of the Secretary, A.I.Ch.E., 25 West 45th Street, New York 36, N. Y.

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Stuckenberg, Fred H., *Lakewood, Calif.*

Thatcher, John R., *Virginia Beach, Va.*
Thomas, Jess W., *St. Joseph, Mich.*
Throne, James L., *Newark, Del.*
Toma, Richard L., *Wyandotte, Mich.*

Wadkins, Robert P., *Deer Park, Wash.*
Waters, E. D., *Pasco, Wash.*
Weber, Frederick A., *Wilmington, Del.*
Wheeler, John W., *Circleville, Ohio*
Wiswell, Richard H., *Pittsfield, Mass.*
Wold, Donald G., *Tulsa, Okla.*

Yannas, John Basil, *Cambridge, Mass.*

Zak, Clarence, Jr., *Toledo, Ohio*
Zaremba, John P., Jr., *Bound Brook, N. J.*
Zeiss, Dennis C., *Midland, Mich.*

AFFILIATE GRADE

Buchanan, James M., *Valley Stream, N. Y.*
Gibson, Kenneth H., *New Hope, Pa.*

Construction on a new facility to produce diammonium phosphate is underway at Virginia-Carolina Chemical. Location is Nichols, Polk County, Virginia, adjacent to the company's superphosphate plant. The 100,000 ton annual capacity unit is slated to go on stream at the end of the year.

A polyethylene plant to be built for Foster Grant is believed to be the first in the United States which will utilize the Agfo Process. Scientific Design, exclusive contractor for the process in this country, will engineer the plant. Site has not yet been chosen.

A.I.Ch.E. RESEARCH COMMITTEE

Final Report from the University of Michigan

Tray Efficiencies in Distillation Columns

PUBLISHED JUNE 1960

Members of A.I.Ch.E. $5.00
Non-members $10.00

Paper Bound

Final Report from North Carolina State College

PUBLISHED SEPTEMBER 1959

Members of A.I.Ch.E. $2.00
Non-members $4.00

Paper Bound

Final Report from the University of Delaware

PUBLISHED DECEMBER 1958

Members of A.I.Ch.E. $5.00
Non-members $10.00

Paper Bound

Bubble-Tray Design Manual

prediction of fractionation efficiency

by the Distillation Subcommittee of the Research Committee

1. Enables the engineer to predict efficiencies for commercial bubble trays used in multicomponent fractionation. 2. Contains sample calculations made on plant-scale columns. 3. Includes calculation form sheets for the use of the reader. (Additional sheets may be purchased.) Members of A.I.Ch.E., $5.00; Non-members, $10.00; Calculation form sheets, $.25. (One bound in book but also available for separate purchase). Hard covers, gold stamped, 6⅛" x 9¼", 94 pages, attractively designed and printed.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS
25 West 45 Street
New York 36, New York

Enclosed is my check for _____ (Add 3% sales tax for delivery in New York City.)

( ) Final Report from the University of Michigan
( ) Final Report from North Carolina State College
( ) Final Report from the University of Delaware
( ) Bubble Tray Design Manual

Name _____

Address _____

Member ( ) Non-member ( )

CLASSIFIED SECTION

Address Replies to Box Number care of:
CHEMICAL ENGINEERING PROGRESS
25 West 45th Street
New York 36, New York

SITUATIONS OPEN

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Research and Development Opportunities in the Food Industry

Challenging positions in the rapidly growing field of food research are available in our process development laboratories. Assignments relate to quality and process improvements of soluble, decaffeinated and regular coffees and the development of new related products.

Section Head

M.S. or Ph.D. in chemical engineering required. At least 8 years experience in food research or a related field and experience in the supervision of technical personnel is necessary.

Project Leaders

B.S. or M.S. in chemical engineering or food technology required. Ph.D. desirable, but not necessary. At least 5 years experience in food research, or a related field, and experience in the guidance of technical personnel is necessary.

Associate Chemical Engineers & Food Technologists

B.S. or M.S. in chemical engineering or food technology required. At least 3 years experience in food research, or a related field is necessary.

Assistant Chemical Engineers & Food Technologists

B.S. or M.S. in chemical engineering or food technology required. Related experience is desirable, but not essential.

These openings provide unusual opportunities for personal and professional growth. Outstanding benefits, including 100% tuition reimbursement for work related courses. Liberal moving allowances. Please submit your resume with salary requirements to: W. T. Neill, Jr.

MAXWELL HOUSE
Division of General Foods Corporation
1125 Hudson Street Hoboken, N. J.

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Mechanical, Chemical and Extractive Metallurgical engineers with outstanding qualifications to fill production, development and engineering positions in processing plants located at Rifle and Uravan, Colorado.

Send resume and copy of college transcript to:

UNION CARBIDE NUCLEAR COMPANY
Division of Union Carbide Corporation
P. O. BOX 1049
GRAND JUNCTION, COLORADO

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Through Growth For

FACILITIES PROJECTS ENGINEERS

at
Expanding Silicone Plant

Our continued growth in silicones has created a need for engineers who are willing to assume complete responsibility for design and installation of chemical process equipment or utilities, services or structural installations, covering all phases from initial estimates to field construction.

BS in chemical engineering or mechanical engineering with 3-6 years chemical plant experience required.

Investigate by writing in confidence to:

R. C. Clark, Manager,
Employee Relations

Silicone Products Dept.

GENERAL ELECTRIC

Waterford, New York

SITUATIONS WANTED
A.I.Ch.E. Members

CHEMICAL ENGINEER—Highly specialized experience in chlorination technology covering photo-chemical, catalytic, vapor phase and related reactions in the development of industrially important products. Industrial and economic surveys. Unusually broad acquaintance in the chemical industry. Box 6-6.

B.S.Ch.E. — 1958—Age 24, family. American. Presently conducting research for Scottish manufacturing firm. Experience in heat transfer and fluid flow. Desire challenging position with good future. Salary secondary to opportunity to learn. Relocate, state side or foreign. Box 7-6.

CHEMICAL ENGINEER — B.S.Ch.E., age 26, family. Four years' process development and project engineering experience. Gas-solids contacting interest. Desire position in production, project engineering, or construction. Location open. Box 8-6.

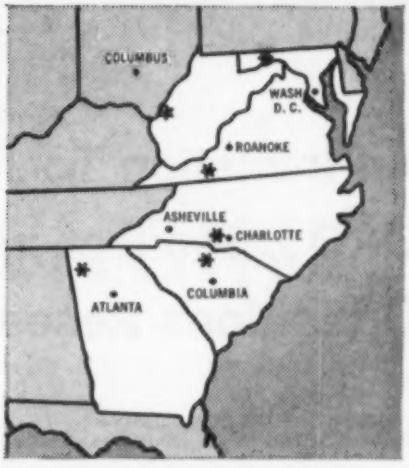
FERMENTATION MANAGER—Development or production. Seek responsible high level position with progressive company. Heavy administrative, supervisory, and technical experience. Ph.D. Sixteen years' pharmaceutical and chemical industry. Box 9-6.

CHEMICAL ENGINEER — B.S.Ch.E. Age 26, married. Two years' experience as process and project engineer in petrochemical plants. Desire process engineering position with opportunity to advance into production supervision. Will relocate internationally for good opportunity. Box 10-6.

APPLIED STATISTICS AND CHEMICAL ENGINEERING—B.S. and M.S. in chemical engineering. About 50% completed M.S. in statistics. Interested in organizing group for effective use of statistics in research, process development or chemical manufacturing. Box 11-6.

BIO-ENGINEER—B.E., thirteen years' R & D, process and equipment design and evaluation, production, purification, drying. Project manager six years. Need opportunity for advancement. Foreign locations considered. Box 12-6.

(continued on page 148)



Celanese

FIBERS COMPANY

A division of Celanese Corporation of America

HAS IMMEDIATE OPENINGS

in the Charlotte, N. C. Headquarters and in Plant locations in South Carolina, Virginia, W. Virginia, Georgia & Maryland

These positions provide opportunity to join a company which is diversifying its fiber operations, a multi-product producer of synthetic fibers in the acetate, triacetate, polyester, regenerated cellulose and nytril fields.

Promotional potential is excellent as planned expansion continues. Most positions, therefore, require men capable of rapid advancement, either into positions of greater technical responsibility, into marketing, or into another of the Celanese divisions.

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PhD preferred, in ChE, ME or Chemistry with 2 to 10 years experience, preferably in synthetic fibers. To perform process design and economic studies related to new fiber research and development; or to develop and improve methods and equipment and supervise pilot plants tests and trials; or new fiber product development; or process design in extrusion development or chemical processing.

PRODUCT DEVELOPMENT

BS in ChE, Chemistry, Textile Engineering or Physics. 2 to 10 years experience in fibers. To develop new applications for man-made fibers; or to develop industrial fiber products including synthetic fiber papers, non-wovens, woven and knit products; or development and research in cellulose compounds, or development associated with synthetic fiber or textile processing.

QUALITY CONTROL

BS in Chemistry, ChE or Textile Engineering with some experience in quality control, development or related field. To establish and maintain a preventive quality control program in the areas of cellulose compounding, extrusion and textile processing.

DYEING & FINISHING

Polymer Chemist, PhD or MS with 2 to 6 years polymer application experience. For work in chemical modification of textile products.

Colloid Chemist, PhD or MS with 2 to 6 years experience in colloid or surface chemistry.

ANALYTICAL CHEMISTRY

BS in Chemistry or Chemical Engineering with 2 or more years analytical experience. For work in analytical laboratory including development of analytical methods.

PLANT ENGINEERING & MAINTENANCE

BS in ChE, ME or EE with 2 to 7 years experience, preferably in the textile industry. For design and estimation on plant modification or expansion; or design and modification of textile machinery or chemical processing or production equipment; or utilities and maintenance involving control instrumentation, power generation, refrigeration processes.

TECHNICAL SERVICE & SALES

BS with technical textile background and up to 10 years experience in synthetic fibers or related industries.

Please send resume, including salary requirements, to Mr. R. V. Butts.

Celanese FIBERS COMPANY

A division of Celanese Corporation of America

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Determine basic process cycles for chemical, petrochemical and natural gas processing plants using cryogenic techniques. Diversified opportunities for separation of gaseous mixtures provide variety of creative assignments in process and equipment design for sales proposals and actual plants.

Qualified applicant will have 2-5 years' experience in process engineering of chemical, petrochemical or petroleum refining plants and strong background in unit operations, heat transfer, thermodynamics, distillation and fluid flow.

Send resume in confidence, including salary requirement to J. J. Rostosky, Manager of Recruiting, Dept. 1919.

Air Products
...INCORPORATED
ALLENTOWN, PA.

SITUATIONS WANTED
A.I.Ch.E. Members

(continued from page 146)

CHEMICAL ENGINEER—Age 33. B.Ch.E., 1951 at University of Florida. Four years' as Ch.E., in chemical pilot plant. Some plant start-up. Some graduate courses. Salary open. Box 13-6.

DEDICATED CHEMICAL ENGINEER (Ph.D.) with unusual combination of experience and training in chemical, nuclear, academic and broad industrial fields (20 years) seek TECHNICAL MANAGEMENT or related staff career position demanding of broad background. Major experience areas: process research, development, and design; complete project management; broad, complex technical and economic feasibility studies; reactor design evaluation; consultation; teaching. Box 14-6.

CHEMICAL ENGINEER—B.S.Ch.E., age 38, family. Seventeen years' diversified experience in economic evaluation of process and equipment alternates, cost studies, process design, development, pilot plant, production in organic chemicals. Desire responsible position. Box 15-6.

MANAGER, RESEARCH AND DEVELOPMENT—Ph.D. Chemist, experienced administrator, laboratory and pilot plants, budgets, personnel, facilities, government contracts, economic studies. Organize new facility or manage existing organization. Engineering and biochemical background. Box 16-6.

TEACHING POSITION WANTED—Ph.D. Ch.E., age 38. Fourteen years' diversified experience in product and process development on bench, pilot plant, and production scale, process design, and economic evaluations. Available September 1960. Box 17-6.

MARKET RESEARCH—B.Ch.E., M.B.A. 1960. Age 33, family. Eight years' diversified R & D experience in chemical, plastics and food industries. Desire to enter market research or development field. N. Y. C. area preferred. Box 18-6.

(continued on page 154)

DOW

CHEMICAL ENGINEERS

THE DOW CHEMICAL COMPANY'S rapid and extensive growth in CHEMICALS, AGRICULTURAL CHEMICALS, PLASTICS and TEXTILE FIBERS creates positions of opportunity with DOW'S Production Plants and Research Laboratories.

DOW representatives will visit

BUFFALO and ALBUQUERQUE JUNE 17 & 18

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You are invited to make an appointment to personally discuss these positions and other current employment opportunities

TEXTILE FIBERS DEPT.
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Research Engineer or Chemist
BS-MS in chemistry or chemical engineering interested in process development for conduct of experimental work on preparation of new polymers and fibers on the bench or miniature pilot plant scale.

Project Engineer
BS-MS Engineer for equipment design, contractor liaison, supervision of draftsmen, construction and equipment installation inspection.

Process Engineer
BS-MS chemical engineering for design of chemical-mechanical processes and equipment for production facilities including heat exchangers distillation columns and special reactors.

Research Engineers
Chemical engineers with 0 to 5 years research and development experience to assist in fiber spinning pilot plant process engineering and experimental operations in connection with product development.

MIDLAND DIVISION
Midland, Michigan

Customer Service and Applications Development
BS-MS in chemistry or engineering for liaison with customer and company research, sales and production departments in chemicals, coatings and plastics.
Also specialty openings for mining engineer with ore benefication and flotation experience, foundry engineer with 2 years foundry experience for foundry chemicals section, "mud" chemist for development of drilling formulations, and chemical engineers with experience in light hydrocarbon production.

Process Design Engineers
BS-MS chemical or mechanical engineering experienced in design or chemical process, pilot plants, production plants and equipment. Work involves preliminary design, calculations and scale up from pilot plant in a central engineering department.

Production Development Engineers
BS-MS chemical or mechanical engineering. Work leading to production supervision. Start in process engineering and trouble shooting on existing full scale plant facilities.

Research and Development Engineers
BS-MS in chemical engineering for product and process research and development. Involves laboratory product research, process improvement and development, pilot plant development and operation, economic analysis.

Instrument Engineer
BS chemical engineer for work with plant instrument maintenance and development.

TEXAS DIVISION
Freeport, Texas

Metallurgist
MS-PhD in metallurgy or metallurical engineering required for research in light metal technology.

Production Engineers
BS-MS in chemical or mechanical engineering for work in organic or inorganic production.

Design Engineers
BS-MS in chemistry or mechanical engineering for engineering design.

Instrumentation Engineer
MS-PhD in physics, chemistry or engineering for process simulation with computers.

Mining Engineer
BS-MS mining or metallurgical engineering, flotation or ore benefication, experience desirable.

The classified section of local newspapers in Sunday and Wednesday editions of week preceding listed dates will give full details regarding local interview arrangements; or write Technical Employment Manager of appropriate division

THE DOW CHEMICAL COMPANY

Are You

PLANT MAINTENANCE ENGINEER OR SUPERINTENDENT

Do You Have

CHEMICAL OR MECHANICAL DEGREE WITH PROGRESSIVE EXPERIENCE INCLUDING MANAGERIAL, IN CHEMICAL PROCESS TYPE INDUSTRY

THEN YOU OWE IT TO YOURSELF TO INVESTIGATE WHAT MARBON HAS TO OFFER YOU.

This is a major opportunity for a man to head up Maintenance (involving construction, preventative maintenance projects, plant utility services, administrative, etc.) with over 50 people, some supervisory.

Attractive relocation provisions to Parkersburg, W. Va. located in the rapidly growing Mid-Ohio Valley. Excellent salary with opportunity for advancement.

Write in confidence to:

N. H. Petersen
MARBON CHEMICAL DIVISION
BORG-WARNER CORPORATION
WASHINGTON, WEST VIRGINIA

PROJECT ENGINEER

Full project responsibility involving overall planning and management of all project phases (design, fabrication, construction, erection and start-up) of multi-million dollar chemical processing plants.

Requires 2-8 years' experience in project, process or design engineering and ability to visualize complete turn-key plants from process specifications and design drawings to set-up a well-conceived operating facility. Drive and desire to execute multi-million dollar contracts from contract signing to customer acceptance essential.

Send resume in confidence, including salary requirement to J. J. Rostosky, Manager of Recruiting, Dept. 1921.

Air Products
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BECHTEL

San Francisco

Refinery and Chemical Division offers immediate employment opportunities for mechanical, chemical or instrumentation engineers capable of assuming responsibility on design of major petrochemical, refinery or similar processing units.

Relocation allowances cover moving costs plus transportation reimbursement for you and members of your family. If you have an interest in a San Francisco assignment, please send a resume of experience, including your present and required salary, to George I. Copeland, Manager of Personnel.

Bechtel
Corporation
220 Montgomery Street
SAN FRANCISCO

SOUTHERN RESEARCH INSTITUTE

R & D ChE's, 0-8 years. Highly challenging and interesting projects, from pilot-plant scale to fundamental lab studies, on fine particles and aerosols, desalting of water, coal chemicals, fertilizers, fluidization of solids, direct reduction of ore, and other industrial problems.

Ideal location near Gulf and mountains.

Send resume to Southern Research Institute, Birmingham 5, Ala.

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2 TO 15 YEARS EXPERIENCE IN PROCESS DESIGN OF PETROLEUM AND CHEMICAL PLANTS
OPENINGS IN CAMBRIDGE, MASS.
CONFIDENTIAL INTERVIEW
SEND RESUME TO W. T. LEWIS

BADGER
MANUFACTURING COMPANY
363 THIRD ST., CAMBRIDGE, MASS.
UN 4-9800

SITUATIONS OPEN

continued on page 152

Placement Bureaus

B.S. to Ph.D. $5 to 25,000
CHEMICAL ENGINEERS
CHEMISTS
Call—Visit Us—Send 5 resumes
SELECTIVE PLACEMENT
EMPLOYMENT AGENCY FOR CHEMISTS AND CHEMICAL ENGINEERS ONLY
17 William Street Newark, N. J.
S. Goodman, M.Sc., C. A. Read, Jr., M.Sc.

ASSISTANT PROFESSOR—Ph.D. in biochemical, chemical or related engineering field for permanent position of teaching and research in food technology department of a California university. Course in engineering principles and unit operations. Excellent opportunities for unit operations and processing research. M.S. and Ph.D. programs in food engineering, chemical engineering, food science, etc. Well equipped chemical and engineering laboratories. Attractive location. $7536-8724 per year depending on qualifications. Send complete resume. Box 1-6.

EXCEPTIONAL HIGH SCHOOL PHYSICAL SCIENCE TEACHING OPPORTUNITY

New, well equipped, science department, community intensely interested in developing strong science department because of mining and chemical processing industries. Salary if B.A.—24 and 2 years teaching experience, $6500; if M.A., $7100. Write **Superintendent, Trona Unified School District, Trona, California,** for complete information.

ENGINEERING SOCIETIES PERSONNEL SERVICE, INC.

(Agency)

New York
8 West 40th St.

Chicago
29 East Madison St.

San Francisco
57 Post St.

These items are listings of the Engineering Societies Personnel Service, Inc. This Service, which cooperates with the national societies of Chemical, Civil, Electrical, Mechanical, Mining, Metallurgical and Petroleum Engineers, is available to all engineers, members and non-members, and is operated on a nonprofit basis. If you are interested in any of these listings, and are not registered, you may apply by letter or resume and mail to the office nearest your place of residence, with the understanding that should you secure a position as a result of these listings you will pay the regular employment fee of 60% of the first month's salary if a non-member, or 50% if a member. Also, that you will agree to sign our placement fee agreement which will be mailed to you immediately, by our office, after receiving your application. In sending applications be sure to list the key and job number.

When making application for a position include eight cents in stamps for forwarding application to the employer and for returning when possible.

A weekly bulletin of engineering positions open is available at a subscription rate of $3.50 per quarter or $12 per annum for members, $4.50 per quarter or $14 per annum for non-members, payable in advance.

Positions Available
New York Office

The New York office of the Engineering Societies Personnel Service, Inc., will be open on Thursday evenings until 7:00 P.M. for interviews.

RECENT GRADUATE CHEMICAL ENGINEER interested in technical sales for paper manufacture and converting. Salary, to $6000 a year. Location, New York, N. Y. W-9041.

RESEARCH AND DEVELOPMENT ENGINEER, graduate chemical or mechanical, experienced in plastersols and their application to fabrics. Thorough knowledge of equipment used and operational processes required. Salary, $10,000-$12,000 a year. Location, South Carolina. W-9040.

PROJECT ENGINEER, chemical, mechanical or electrical engineering graduate, 30-40, with plastics extrusion experience desirable. Electrical engineering training or experience also very desirable since some process control work will involve electrical problems. Duties will entail process control and development work; also development of special inspection equipment. Salary, $7100-$8150 a year. Location, Newark, N. J. area. W-9036.

CHEMICAL ENGINEER, graduate, with two to three years' experience in industrial waste disposal. Salary open. Location, eastern Pennsylvania. W-9026(b).

RECENT GRADUATE CHEMICAL ENGINEER interested in process engineering in petroleum to train in the design of units in oil refining, economic studies, additions, etc. Will be trained for twelve months prior to overseas assignment. Salary, $6600 a year plus or minus. Location, New York, N. Y. W-9022.

SALES ENGINEER, mechanical or chemical engineering graduate, with at least three years' field sales experience calling on process and food industries to sell pressure filters. C nsiderable traveling. Territory, Eastern States. Headquarters, New York, N. Y. Salary, $8000-$12,000 a year plus bonus and expenses. W-9007.

CHEMICAL PROCESS ENGINEER, graduate, with 10 years' experience in the chemistry of plastic compounds. Will assist in design of extruding equipment and will take compounds to various plants and supervise the extrusion. Some travel. Salary open. Location, New York, N. Y. W-9071.

ASSISTANT SUPERVISOR for material control laboratory, young, graduate chemical, mechanical or metallurgical, with background in metallurgy. Laboratory does mechanical testing and chemical analysis of raw materials. Salary, about $7020 a year. Location, Conn. W-9044.

BIOCHEMICAL ENGINEER to work in the processing of biochemical extractions. Should have a minimum of two years' of biochemical manufacturing experience. Opportunity for advancement. Salary, to $9000 a year. Location, northern New Jersey. W-8989.

RATING ENGINEER, B.S. M.E. or Ch.E., with two to three years' experience, capable of designing heat exchangers suitable to the process and marine industries. Salary, $6000-$7200 a year. Location, northern New Jersey. W-8951.

SALES ENGINEER, degree or equivalent with preferred emphasis in chemistry or metallurgy or chemical or metallurgical engineering, with a minimum of three years' in metallurgical or chemical sales or engineering or other closely related activity, to promote use of and sell chemical, ceramic, metallurgical, etc. products to a variety of industrial accounts. Travel approximately 60% away from home office. Salary, $8500-$9000 a year. Apply by letter giving complete information, including current salary and expected salary. Headquarters, Pennsylvania. W-8933.

ESTIMATOR, degree in chemical engineering helpful but not required; knowledge of engineering or accounting, and ability to read blueprints, plus three to four years' estimating experience. Will make detailed and/or general estimates of plants (refinery, chemical, petro-chemical, power plants), either foreign or domestic. Salary, $6000-$7200 a year. Location, New York City. W-8926.

SENIOR QUALITY ENGINEER, graduate mechanical, chemical, industrial or electrical, plus formal training in statistical quality control and/or design of experiments, with three to five years' experience in the application of statistical quality control techniques and practices, preferably in paper or textile fields. Will plan and aid in setting up a five program statistical quality control plan in an operating division of an international multi-division company. Salary, maximum to start, $7860 a year. Excellent opportunity for advancement. Location, upstate New York. W-8912(a).

ENGINEERS. (a) Plant Manager, graduate chemical, for new plant manufacturing thalic anhydride. Experience in this field necessary. Salary, $10,000-$12,000 a year (b) Assistant to Plant Manager, graduate chemical, with three to five years' experience in chemical process plant. Salary, $8000-$10,000 a year. (c) Plant Manager or Chief Process Engineer, graduate chemical, with considerable experience in butadiene or styrene processes. Salary, $10,000-$12,000 a year. Location New England. W-8896.

PROCESS ENGINEER, degree in chemical engineering, with ten years' experience in cryogenic work such as low temperature processing design, air separation, separation of low hydrocarbons, argon recovery, hydrogen purification, low temperature extended surface exchanger design, trouble shooting in operating low temperature air separation plants. Salary open. Location, New York, N. Y. W-8878.

MANAGER, Chemical Laboratory, for a large multiplant producer of chemicals and minerals, with a thorough knowledge of methods and equipment used in mining inorganic chemicals; supervisory experience in a comparable laboratory environment making practical applications of research methodology. Will supervise staff of approximately 100 persons, in research and development work related to agricultural minerals and chemicals and including the development and policing of some process controls. Modern and ample facilities and equipment. Salary, $15,000-$18,000 a year, plus excellent benefits. Location, Florida. W-8872.

DIRECTOR OF RESEARCH, Product Development, chemical or chemistry background, with experience in chemicals, drugs, cosmetics or detergents necessary. Will supervise personnel to develop new related products and up grade existing products. A practical viewpoint required rather than basic research. High speed production including fabrication, mix, fill and pack. Salary, $25,000-$35,000 a year plus other benefits. Headquarters, New York, N. Y. W-8871.

DESIGN ENGINEERS. (b) Instrumentation, graduate chemical or mechanical engineer with chemical engineering experience, to design and engineer complete instrumentation system for process control of heavy chemical plants; design electrical and pneumatic control systems, prepare specifications, etc. Salary, to $10,500 a year. (c) Heat Transfer, graduate chemical or mechanical engineer, with three to five years' experience, to design and select devices and equipment used for heat transfer and fluid flow under all conditions and pressures for heavy chemical plants; solve heat transfer and fluid flow problems using principles of strength of materials, etc. Salary, to $9000 a year. Company pays placement fees. Location, New York, N. Y. W-8843.

MANAGER, PRODUCT DEVELOPMENT ENGINEERING graduate mechanical, chemical, ceramics engineering or physical chemistry, with considerable experience in resistors or other electronic components; vacuum systems, vacuum evaporation, resistive or semi-conductive films; conductivity and modes of conductivity in films or solids with respect to pure and doped crystalline structures. Must have ability to conceive and implement new product innovations. Location, Midwest. W-8842(a).

SALES ENGINEERS, preferably with one to two years' chemical engineering sales experience, for training program. Salary open. Location, New York and New Jersey. W-8830.

San Francisco Office

INSTRUMENT ENGINEER, graduate chemical, electrical or mechanical, with three to seven years' experience in refinery or chemical plant instrumentation, to engineer systems, write specifications for basic instruments, control systems, safety interlocks and relief systems for refineries and chemical plants. Some experience in atomic energy field helpful. Salary, $6600-$9540 a year. Must be U. S. citizen. Apply by letter. Location, Southern California. SJ-5272-R.

ENGINEERS. (a) Supervisors and Senior Designers, graduate mechanical or chemical, with five to ten years' experience in design of refineries, petroleum, petro-chemical plants. Will work with project group in carrying out engineering work relating to design, plans, specifications and construction. Salaries: to $15,000 a year for supervisors; to $12,000 for seniors. (b) Designers, graduate chemical, well experienced in designing process plants from flow sheets and other related data. Salary, about $10,000 a year. Position with an engineering builder. Location, San Francisco. SJ-5093.

SALES ENGINEERS with chemical or mechanical engineering training, preferably under 35. Knowledge of hydraulics, piping and with sales experience and in-plant experience (familiar with plant machinery and equipment). Will sell water treating equipment and softeners to mechanical contractors and large industrial users. Salary, about $6600 a year base plus 2% commission on sales over $150,000, plus expenses (potential $10,000-$12,000). One for San Francisco Bay area; one for Los Angeles (must know Los Angeles area). SJ-5225.

LAB CHEMIST, graduate chemical engineer, recent graduate to one with about three years' working experience, with aptitude or training for lab work involving production controls (inspection and quality control) involving raw materials, process formulation, production tests; should be able to work with production plant personnel. For a manufacturer of printed forms. Salary, $6000-$7200 a year. Location, San Francisco East Bay. SJ-5215.

SITUATIONS OPEN

(continued from page 150)

CHEMICAL ENGINEERS

Several openings due to expanding operations. These positions are in the central Research and Development department of a diversified corporation located in northwest Chicago suburb. Relocation allowance. Openings in both Research and Pilot Plant work.

EXPERIENCED CHEMICAL ENGINEER—with 5 to 10 years experience in design and operation of refinery pilot plants. Man to assume complete charge of pilot plant design and construction.

CHEMICAL ENGINEERS—B.S., M.S., or Ph.D. for laboratory and pilot scale work. Up to 5 years experience.

Please Send Resume to:

GREAT LAKES CARBON CORP.
8210 Austin Ave.,
Morton Grove, Ill.

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1—Pfaudler 100 gal. glass lined jacketed reactor, complete with anchor type agitator and drive
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2—Blaw Knox SS 600 gal. vacuum receivers, 29" Hg
1—Steel and Alloy Tank Co. 100 gal. type 347 SS pressure tank, 250 psi jacket
1—Struthers Wells type 347 SS pressure vessel 300 gal., complete with agitator and drive
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2—Steel jacketed reactors 2500 gal.
1—18,000 gal. aluminum storage tank
5—Aluminum storage tanks, 1300 gal. each

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3—Link Belt steel rotor louvre dryers, Model 207-10, 310-16, 604-20
1—Stokes Model 59DS steel rotary vacuum dryer, 5' x 30'
2—Louisville rotary dryers, 8' x 50', SS, complete
1—Allis Chalmers SS rotary dryer, 6' x 50', complete with drive, motor, etc.
1—Buflovak SS jacketed rotary vacuum dryer, 3' x 15'
1—Stokes SS jacketed rotary vacuum dryer, 2' x 6'
1—Traylor 11' x 156' rotary kiln, 2 tires, welded 7/8" shell, complete with drive and motor
1—Louisville rotary steam tube dryer, 8' x 45'
1—Rotary dryer 7' x 60', 2 tires, 1/2" shell, complete with drive, motor and all auxillary equipment
1—Rotary dryer 6' x 64', 2 tires, 1/2" shell, complete with drive, motor and all auxiliary equipment
1—Rotary dryer 6' x 56', 2 tires, 1/2" shell, complete with drive, motor and all auxiliary equipment
1—Rotary dryer 6' x 50', 2 tires, 1/2" shell, complete with drive, motor and all auxiliary equipment
1—Rotary dryer 6' x 35', 2 tires, 1/2" shell, complete with drive, motor and all auxiliary equipment
1—Rotary dryer 4' x 20', 2 tires, 1/2" shell, complete with drive, motor and all auxiliary equipment
3—Buflovak steel jacketed rotary dryers, 3' x 15', 5' x 20', 5' x 35'
1—Traylor 4' x 40' rotary dryer
1—Rotary dryer 6' x 36'
2—Stokes Model 138J-20 single door vacuum shelf dryers, 20 shelves, complete
1—Western Precipitation Corp. SS pilot spray dryer, Type N-2

FILTERS

3—Dorrco rubber covered filters, 6' x 2'
12—Sweetland #12 filters with 72 SS leaves
1—Niagara SS filter, Model 510-28

THE GELB GIRL—JUNE 1960

1—Oliver SS rotary pressure precoat filter, 6'3" x 8'
1—Oliver horizontal filter, 3'
10—Shriver plate and frame filter presses, 12" x 42"
1—Shriver aluminum 30" x 30" P&F filter press, 30 chambers
1—Sperry aluminum filter press, 18" x 18" P&F, 16 chambers

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1—AT&M 48" SS suspended type centrifuge, complete with plow, motor and imperforated basket
1—Fletcher 48" SS center slung centrifuge, complete with perforated basket and motor
4—Tolhurst 40" center slung rubber covered centrifuges with perforate baskets and motors
2—Fletcher 40" center slung rubber covered centrifuges with perforated baskets
1—AT&M 40" SS suspended type centrifuge, complete with motor and plow with perforate basket and motor
1—Western States vaportite type 316 SS under driven centrifuge with 36" perforate basket, with unloader and motor, bottom discharge

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15—Robinson type 304 SS horizontal blenders, 255 cu. ft.
1—Howes horizontal rubber covered ribbon blender, 40 cu. ft.
2—Sturtevant #7 dustite rotary batch blenders, (NEW)
1—Baker Perkins Size 16 Type TRM, 150 gal. jacketed double arm sigma blade mixer with vacuum cover
1—Baker Perkins Size 16, Type UUEM, 150 gal. jacketed double arm dispersion type mixer, complete with compression cover and 100 HP motor
1—Baker Perkins Size 20, 2000 gal. double arm jacketed vacuum mixer with double naben blades
1—Entoleter impact mill type PPM-27
1—Stokes SS granulating mixer, Model 211
3—Banbury #1 mixers, chrome plated rotors, 50 HP motors

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1—Badger type 316 SS bubble cap column, 36" dia. with 8 trays
1—Struthers Wells type 316 SS heat exchanger, 330 sq. ft.
1—Condenser Service type 316 SS heat exchanger, 350 sq. ft.
3—Badger type 316 SS heat exchanger, 500 sq. ft. and 600 sq. ft.
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(continued from page 152)

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BOX 3-6

A Preprint of all SITUATIONS WANTED notices is mailed directly monthly to thousands of personnel and recruitment officers nationally.

Route to Employment Director

CHEMICAL ENGINEERS

SITUATIONS WANTED

SITUATIONS WANTED — A.I.Ch.E. Members

(continued from page 148)

CHEMICAL ENGINEER—B.S.Ch.E. Twelve years' experience in process engineering, design, development and start-up operations in nuclear industry. Desire position with process or engineering firm. Present salary $10,500. Box 19-6.

CHEMICAL PLANT MANAGER—B.Ch.E., age 41. Offers broad engineering and business background in chemical industry. At present, works manager of multi-product plant. Desire challenging position with growth probabilities. Box 20-6.

CHEMICAL ENGINEER — Age 36. Ten years' diversified experience — sales process engineering and production. Heavy chemical and equipment specialist. Location and salary open. Box 21-6.

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LATIN AMERICAN LIAISON OR MANAGEMENT—Chemist-manager, Ph.D. Biochemical, fermentation, pharmaceutical, engineering experience. Capable responsible charge new or established venture. Excellent knowledge language, customs, people. Deeply interested in future of chemical industry south of the border. Box 23-6.

CHEMICAL ENGINEER—B.S.Ch.E. 1955. Age 31. Two years' experience in petroleum and petrochemical plant construction, inspection, and design. Three years' experience R & D solid propellants for rockets. Desire challenging position. Box 25-6.

PROCESS DESIGN ENGINEER—Ten years' experience design and project work and operation of natural gasoline plants. Wants responsible position with potential supervisory capacity and future in design. B.S. and M.S. Chemical Engineering. S.W. location. Box 26-6.

PROCESS ENGINEER—M. Sc. Age 35. Registered professional engineer (by examination) from the State of Illinois. Eight years' diversified experience in petroleum and petrochemical plants. Experience in start-up and trouble shooting. Strong technical background. Desired salary $7,500. Box 27-6.

NON-MEMBER

RESEARCH CHEMICAL ENGINEER—B.S. Ch.E. P.E. Twelve years' experience in process development, improvement, economic evaluations, statistical techniques, organics, polymers, has exhausted present potential and desire staff level position leading to management. Box 24-6.

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Advertisements in the Classified Section are payable in advance at 24c a word, with a minimum of four lines accepted. Box number counts as two words. Advertisements average about six words a line. **Members of the American Institute of Chemical Engineers in good standing are allowed two six-line Situation Wanted insertions (about 36 words each), free of charge a year. Members may enter more than two insertions at half rates.** Prospective employers and employees in using the Classified Section generally agree that all communications should be acknowledged as a matter of courtesy but recognize circumstances where secrecy must be maintained. Answers to advertisements should be addressed to the box number, Classified Section, Chemical Engineering Progress, 25 West 45th Street, New York 36, N. Y. Telephone COlumbus 5-7330. Advertisements for this section should be in the editorial offices the 15th of the month preceding publication.

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Cleveland 15—Harry L. Gebauer, Dist. Mgr., 1501 Euclid Ave., SUperior 1-3315.

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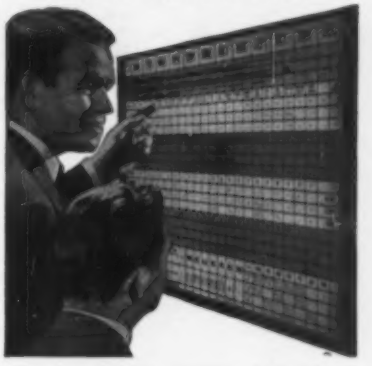

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For more information, circle No. 22

News and Notes of A.I.Ch.E.

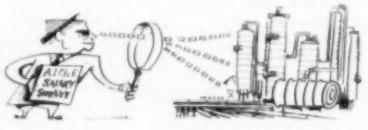
United Engineering Trustees' Campaign—A.I.Ch.E. is getting a very welcome return from the twelve sections of the Institute that have reconstituted their campaigns. The Institute is now up to 102% of its quota. Recently a letter of appeal to all members of the A.I.Ch.E. who have not given was sent out over President Jerry McAfee's signature; this will be absolutely the last chance that chemical engineers have to subscribe to the United Engineering Center. A contribution at this time will be a significant gesture on the part of this generation toward a technical home for future generations of engineers in the United Nations area. News from Los Angeles is that the campaign there is under the direction of Eugene C. Herthel. Gene recently retired as vice-president of Sinclair, in charge of the Harvey Laboratories; so office space and secretarial and telephone services for the campaign have been contributed by the Fluor Corporation.

Registration fees—At its April meeting Council voted the following changes in registration fees for National and Annual meetings: All members, $6.00; members of other E.J.C. societies, $6.00; nonmember chemical engineers, $18.00. The fees for non-engineers, ladies, and students remain the same.

Preprints of meeting papers—The perennial question of whether or not to preprint meeting papers has arisen once more . . . it is of course an economic problem. Although strong sentiment is frequently expressed in favor of preprinting papers (some members even advocating the preprinting of every paper), the sad truth is that very few are purchased . . . even though the price barely covers costs. Since 1958 the sales of preprints have fallen below the total cost, sometimes as few as seventy copies of each paper, on an average, being sold for a meeting attended by from 1,000 to 2,000 people. The conclusion: those members who want preprints must support the project by buying them.

South Texas Section contributed a generous $1,000 to the United Engineering Center Building Fund, in addition to the individual pledges made by members of the section. . . . A ten-week refresher course at the University of Washington for chemical engineers preparing for professional licensing exams was organized by the **Southwest Washington Section** and sponsored by local industries. . . .

Northern California's *Flowsheet* carried recently a report on a survey of section members similar to that conducted by the South Texas Section last year . . . Among the topics that received a negative vote from the large majority of those answering



were compulsory registration (70.5%), collective bargaining (78.4%) . . . interestingly, although 78.4% were opposed to collective bargaining for engineers, only 70.5% thought it incompatible with professional status. As far as the A.I.Ch.E. was concerned, it received a generally satisfactory or better rating for supporting chemical engineering education, assisting and inspiring chemical engineering students, aiding professional development, cooperating with other engineering societies, maintaining a high caliber of professional publications and high ethical standards, awarding recognition to technical and professional achievements. Weak points were counseling recent graduates and enlightening the public on chemical engineering. Large majorities too thought that the A.I.Ch.E. should conduct periodic salary surveys, operate an employment clearing house at meetings, and survey company policies on treating engineers as professional men. Of the 550 section members, 292 responded to the questionnaire. **New York Section** is considering a by-law amendment to make any section member who holds a national office (president, vice-president, secretary, treasurer, director) in the Institute an ex officio director of the section, with a vote on the section's Executive Committee.

Cooperation between Local Sections and Student Chapters was investigated in a recent questionnaire sent to Student Chapter Counselors by T. W. Tomkowit, secretary of the Student Chapters Committee. Counselors were asked what help they would like from their Local Section and were informed of the appointment by Charlie Huckaba, chairman, of a subcommittee to the Student Chapters Committee to help "increase Local Section participation in Student Chapter activities." Also directed toward aiding student chemical engineers was a summary of the committee's activities, accomplished and projected, sent to each chemical engineering department by the Education Projects Committee, headed by Marriott W. Bredekamp.

Recognized Schools—Council recently on the recommendation of the Admissions Committee, of which R. F. Shaffer is chairman, determined that to satisfy the requirement for membership "schools of recognized standing" should be defined as schools with accredited chemical engineering curricula, plus those schools having an active A.I.Ch.E. Student Chapter, plus certain foreign schools.

Problems, Anyone?—Recently we issued the fifteenth booklet of chemical engineering problems—this one is in the nuclear area. A long-continuing project of the Chemical Engineering Projects Committee, the problems

have been supervised for some time by Frank A. Anderson of the University of Mississippi; as a matter of fact, Frank recently wrote me that he has just completed his eighteenth year in this work.

Colonel McAfee—Jerry McAfee is now a Kentucky colonel. On his recent speaking tour he addressed the Local Section at Louisville, where he was presented with his sealed commission. Jerry now has to be addressed as "Colonel, suh."

F.J.V.A.

For more information, circle No. 134 ➤

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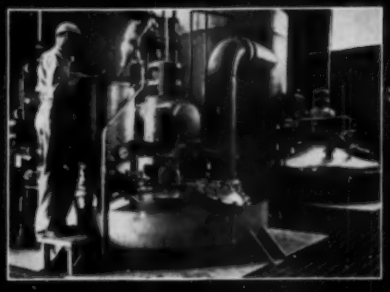

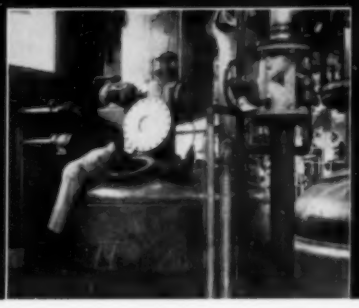

GOOD MIXING is key to process control in butadiene-styrene reactors at new Dewey and Almy plant.

How they keep molecules from running amok in push-button latex plant

Look at the heart of this process, and you'll see LIGHTNIN Mixers working.

They're helping to make little molecules into big ones—20 million pounds of them a year—at the new Owensboro, Ky., plant of Dewey and Almy Chemical Division, W. R. Grace & Co.

Process control is exceptionally tight on the new plant's two parallel lines producing butadiene-styrene latices and PVAc emulsions for a host of uses. Either line can produce many types of emulsions to meet customers' special needs.

What mixers do

In each polymerization reactor, a turbine-type LIGHTNIN Mixer whips incoming monomers into an emulsion. Then, as the batch heats up to its catch point, the mixer keeps it turning over rapidly at uniform temperature throughout.

Once polymerization begins, heat control is critical; a rise of 10° F will double the reaction rate. Turbulence and flow from the big flat-blade turbines provide a high rate of heat transfer that helps to get excess heat out of the batch as rapidly as possible. As a result, heat-sensing devices in the reactor can feed accurate data back to the plant's automatic control center.

Ahead of the reactors, other LIGHTNIN Mixers swiftly combine monomers, emulsifiers, and catalysts to make up the reactor charge. At the far end of the line, LIGHTNIN Mixers also blend finished products, prior to shipment.

What's your mixing problem?

For your fluid-mixing operations, you can get LIGHTNIN Mixers as advanced as your own thinking. On complex mixing jobs, you can save precious hours of engineering by coming to MIXCO—and get the right answer, with mixing results unconditionally guaranteed.

On *any* fluid-mixing job, LIGHTNIN Mixers give you the widest possible choice of standard mixer designs, in sizes up to 500 hp, with maintenance features that keep your mixing costs low for years to come. Your LIGHTNIN Mixer representative can tell you more. Look him up in *Chemical Engineering Catalog* or the yellow pages of your phone book, or write to us.

Lightnin Mixers

MIXCO fluid mixing specialists

MIXING EQUIPMENT Co., Inc., 199-f Mt. Read Blvd., Rochester 3, N.Y.
In Canada: Greey Mixing Equipment, Ltd., 100 Miranda Ave., Toronto 19, Ont.

For more information, turn to Data Service card, circle No. 23